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ALBERTA HAIL PROJECT

FIELD PROGRAM 81

ATMOSPHERIC SCIENCES PROGRAM

Atmospheric
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RESEARCH COUNCIL
Natural Resources Division

ATMOSPHERIC SCIENCES PROGRAM

ALBERTA HAIL PROJECT FIELD PROGRAM
1981

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PREFACE

This report continues the series of field program reports covering atmospheric science field research activities at the Alberta Research Council.

In January 1981, a five year plan for weather management in Alberta was developed by the Alberta Research Council with input and guidance from Alberta Agriculture and the Research Council's Atmospheric Sciences Program Committee. As a result of extensive and fruitful discussions, research conducted by the Atmospheric Sciences Program also respects the needs and aspirations of Alberta Environment and Alberta Agriculture's Advisory Committee on Weather Modification. The program involves numerous aspects of weather modification research and operations related to developing capabilities for the management of atmospheric water resources in Alberta. The economics of rainfall redistribution are readily seen. The growing concerns over insufficient water supplies in southern Alberta might be relieved by augmenting mountain winter snowfalls. Additionally, some evidence suggests that the emissions of natural gas processing plants may be affecting precipitation processes. Such concerns have lead to some diversification within the program over the past year. However, efforts in hail suppression research have been maintained because of the high annual agricultural losses, now estimated at $100,000,000.

This report summarizes the various activities and data collected during the 1981 field season. The material in this report has been contributed by personnel of the Atmospheric Sciences Department and INTERA Environmental Consultants. These contributions are gratefully acknowledged.

The Alberta Hail Project would like to thank the farmers of Alberta who submitted storm data either by mail or telephone, and those within the project area who maintained rainfall records.

SUMMARY

HAIL DATA

During the usual cloud seeding period 20 June to 10 September, hail was reported in the project area on 39 days (3 per cent above the 25 year average). The 1613 hail reports during this period were 34 per cent below average.

During the hail season from 1 June to 30 September, there were 57 hail days in the project area (21 per cent above average) and 1827 hail reports were received (32 per cent below average).

STORM FORECASTING

There were 507 successful rawinsonde and Airsonde soundings during the field season. Forecasts during the period 20 June to 31 August were 73 per cent correct to within one CDC category and 85 per cent correct in forecasting Hail or No Hail.

RADAR COMPUTER OPERATIONS

Radar operations were moved from Building 29 to a double wide ATCO trailer adjacent to the radar towers. Recorded radar data were: S-band 75.6 hours and C-band 680.3 hours. The X-band tracking system operated a total of 367 hours.

PRECIPITATION NETWORK

A volunteer-operated precipitation measuring network of 562 stations was operated from 1 June to 31 August. No hailpad networks were operated this year.

SINGLE STORM SEEDING EXPERIMENT

Data gathering for single storm seeding experiment in 1981 was exploratory, with some practice aircraft penetrations on 3 days for 2 hours and 46 minutes of flight time.

STORM CHASE

The storm chase program operated from 6 July to 21 August. During this period, 64 rain samples, 49 time-resolved hail samples and 29 hailpads were obtained. In addition, 58 hail samples were obtained from volunteers.

RESEARCH AIRCRAFT

The Cessna 441 Conquest completed its first year (test and development year) logging 43.9 hours of flight time.

GROUND GENERATOR ASSESSMENT PROGRAM (GGAP)

The GGAP program operated in an area south of Calgary from 20 June to 21 August. One arc and two coke generators were tested at the Colorado State University Cloud and Aerosol Simulation Lab for generator effectiveness and rates of nucleation.

CLOUD SEEDING

The cloud seeding control room was moved to Building 38. The cloud seeding operational period was reduced to cover the period 20 June to 31 August and one seeding aircraft was dropped from the INTERA contract. Three aircraft carried acetone burners and two aircraft were equipped with "pencil" flare systems. Cloud seeding crews flew 690.6 hours; 40 days required seeding.

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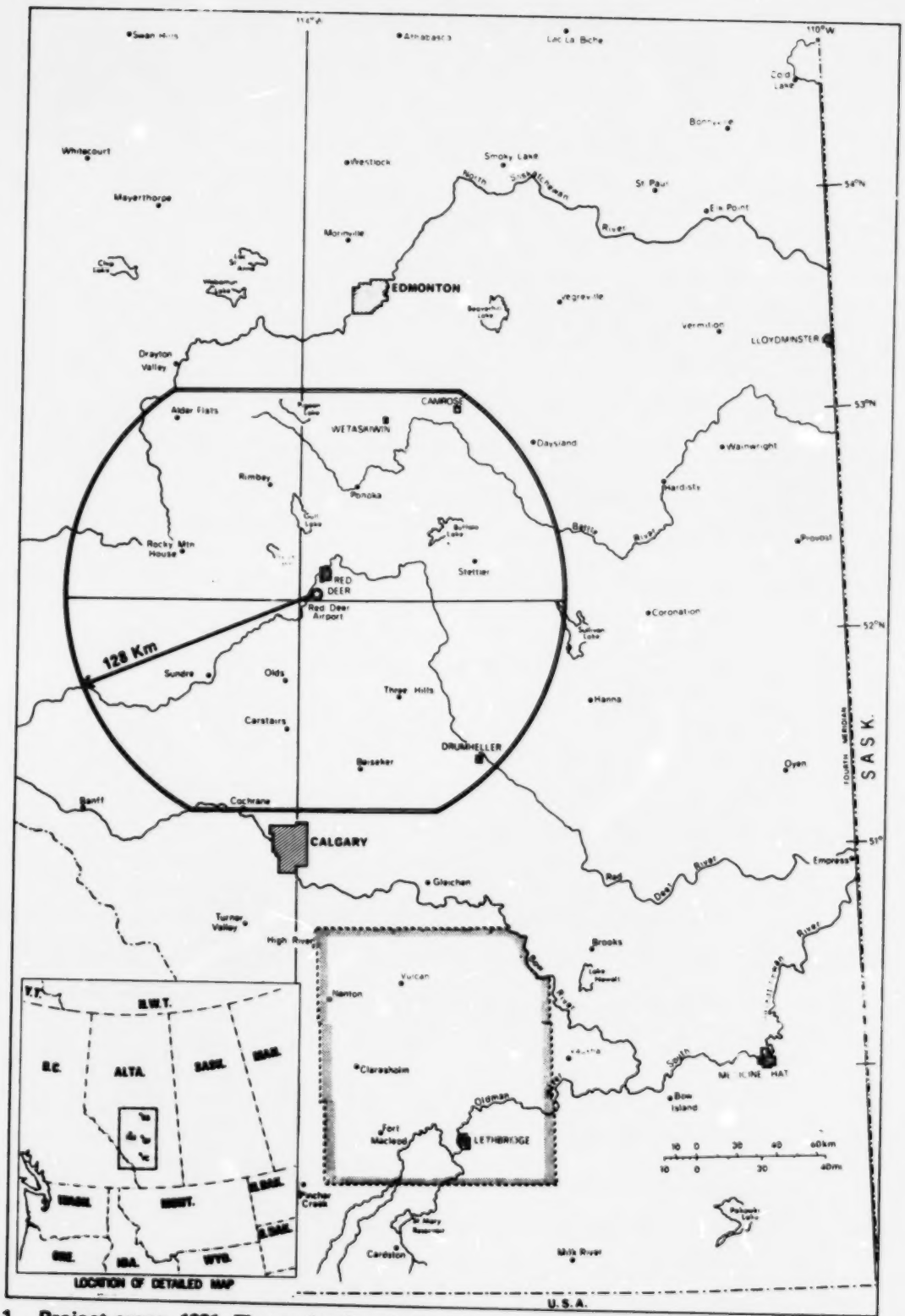


Figure 1. Project areas, 1981. The project's principal target area (using only aircraft for cloud seeding) is centered on the radar site located at the Red Deer Industrial Airport. A second target area using ground based silver iodide generators is located in an area south of Calgary.

INTRODUCTION

The Alberta Hail Project is a comprehensive weather modification research program of the Government of Alberta. The Alberta Research Council, on behalf of Alberta Agriculture (principal funding agency), acts as the central management and research agency for weather modification activities in Alberta. The Atmospheric Sciences Department of ARC is responsible for program design and implementation (see Appendix I for the project organizational chart and list of personnel).

The programs of the ASD are designed to a) investigate the processes which lead to hailfall, rainfall and snowfall, b) establish operational cloud seeding procedures and techniques c) evaluate the effectiveness of cloud seeding to determine the practical and economical feasibility of various weather modification programs.

The project's principal target area of 48,000 km^2 is centered on the radar site located at the Red Deer Industrial Airport (Figure 1). A ground based generator area, operated by I.P. Krick and Associates is located in an area south of Calgary (see section on Ground Generator Assessment Program).

1981 HAILFALL ACTIVITY

Hail occurred on 57 days (hail day: 1 or more hail reports) in the project area, 21 per cent above the 25-year (1957 - 1981) average for the period 1 June to 30 September. A total of 1827 hail reports were received; 32 per cent below average. In the northern area, hail was reported on 44 days, 13 per cent above average; the 769 hail reports were 46 per cent below average. In the southern area, hail was reported on 48 days, 26 per cent above average with 1058 hail reports received, 15 per cent below average. Appendix 2 summarizes hail days and hail reports on a monthly basis.

Major storm days (100 or more hail reports) occurred only in the southern area on 23, 26 June and 28 July. From these three days, 327 hail reports were received accounting for 31 per cent of the hail reports for that area. A daily summary of all hail reports within the project area is included in Appendix 2. The locations of hail reports within the project area are included in Appendix 5. Tracks of all storms from which hail was reported are shown in Figure 2. Some scattered reports of hail were received for a few other days and areas, but were not organized enough to determine hailswaths. In some cases, additional hailfall data was acquired from Alberta Hail and Crop Insurance to define hailswaths.

Hail reporting cards and a project brochure were mailed (via Householder Mailings) to 70,649 farms in the province, 18,499 of these were inside the project area. Additional cards were sent to those who reported hail, in case they received more hailstorms. During the reporting period from 1 June to 30 September, 732 hail reports were received from farmers throughout the province.

Telephone survey sheets (lists of all people on a rural telephone exchange) were updated this year giving a more complete and accurate list. Telephone surveys were conducted on 42 days between 20 June and 31 August resulting in 1430 hail reports from inside the project area. Surveys of storms which extended outside the project area accounted for 18 hail reports.

STORM FORECAST OPERATIONS

INTRODUCTION

The Storm Forecast Group continued its support to other field operations, although at a reduced level because of summer staff reductions (from 14 assistants to 9). Cancelled activities included weather office radar surveillance, Rocky Mountain House (CYRM) rawinsondes (1400, 2400 UTC), and the Red Deer (CAQF) PIBAL (1500 UTC) and replaced by twice daily rawinsondes at Red Deer. Some non-operational activities such as radar reports to AES (an exchange service) and drafting for ARC reports also could not be maintained.

Some reductions in operational committments, however, were beneficial to the Storm Forecast Group. Two major field research operations were successfully carried out (CCOPE and STRESS, described below), the staff being augmented by temporary student manpower.

WEATHER OFFICE

The weather office was operational from 19 June through 31 August. Meteorological communications equipment and circuits were leased from CNCP and AES. A receive-only teletype was used for circuit 131 and a new INFOMODE 200R send-receive teletype for circuit 130. Two Alden recorders provided weather maps and satellite photographs.

Three students maintained two shifts daily, 06:30 - 14:15, and 13:15 - 21:30 MDT. Duties included filing and archiving pertinent meteorological data, tephigram and sur-

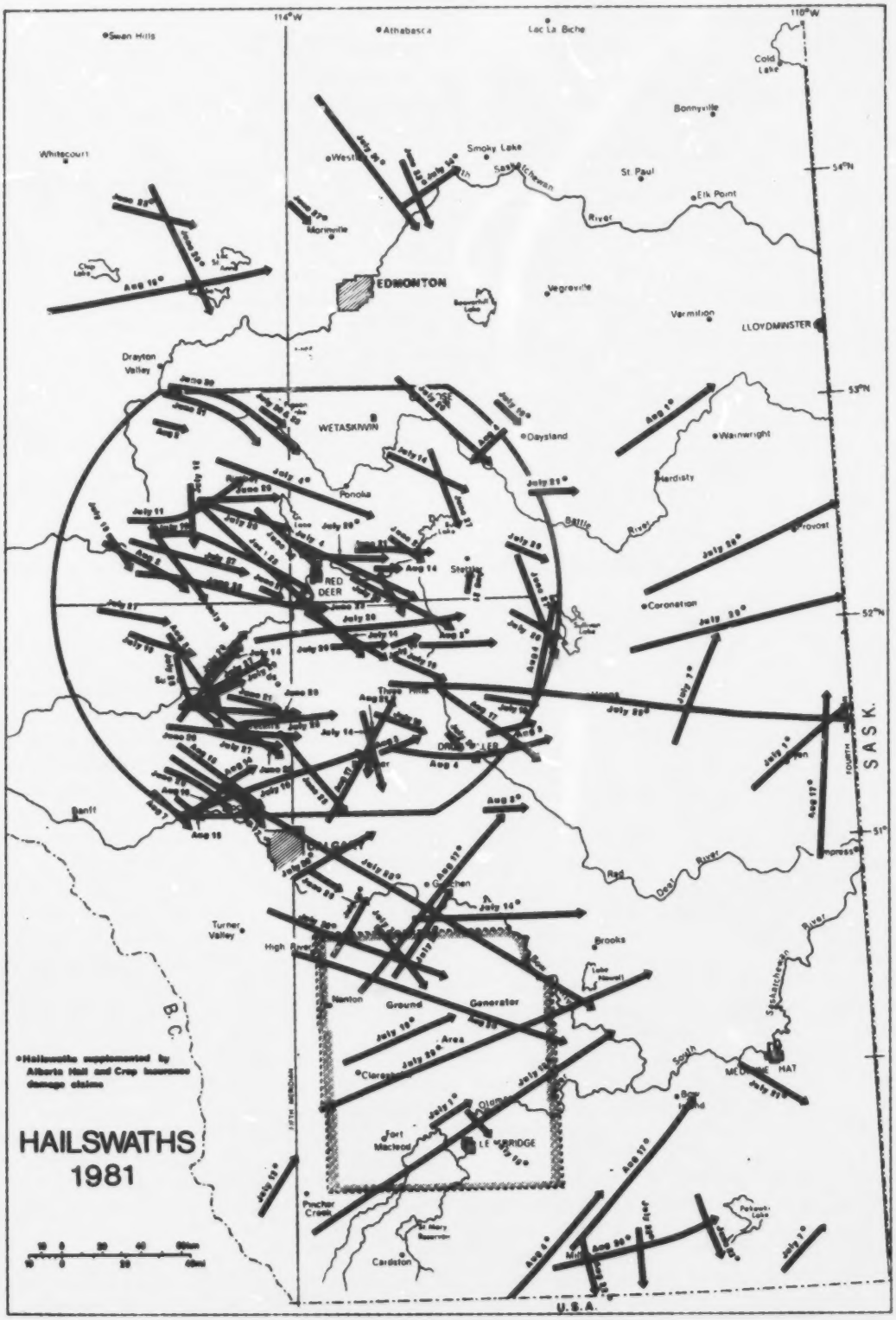


Figure 2. Hailstorm tracks during 1981 for storms with pea or larger hail reported.

face map plotting, and transmitting CYYC and CYQF rawinsonde data over the AES teletype network.

The AES Alberta Weather Centre in Edmonton continued its support, providing EGDEX and forestry weather information via telecopier, and synoptic data from the CMC Spectral prog grid point circuit, interpolated for Red Deer. This support has proven valuable for computation of ASD forecast products. In return, the ASD weather office transmitted all rawinsonde soundings over teletype and provided daily hail and forecast summaries via telecopier to AES.

UPPER AIR OPERATIONS

The format for atmospheric soundings followed in previous years was changed considerably for the 1981 field operations period. Reductions in staffing, budget considerations, and participation in field research projects were the main factors influencing this change.

Two rawinsonde stations (as opposed to three in previous years) were operated throughout the program, one at the University of Calgary (CYYC), and the other at field headquarters in Penhold (CYQF). Two soundings were released each day at both stations (normally 07:15 and 17:15 MDT) with the addition of serial ascents during the STRESS research program (see STORM FORECAST RESEARCH FIELD OPERATIONS). The Rocky Mountain House rawinsonde station (CYRM) was operated for two days during the STRESS program and was manned by Calgary rawinsonde personnel.

During the CCOPE study in Montana (see STORM FORECAST RESEARCH FIELD OPERATIONS), personnel from the weather office were called upon to assist in the CYQF rawinsonde releases. With considerable effort of all involved, the weather office and rawinsonde operations were able to continue uninterrupted.

Table 1 indicates the distribution of the 1981 upper air soundings. The CYYC rawinsonde station made 11 balloon releases prior to regular operations which commenced on 15 June. Two releases daily then continued until termination on 31 August. Interruptions occurred on 19 and 20 August when CYYC operations were relocated to CYRM for 13 serial ascents in conjunction with STRESS field operations. Seven serial ascents were also performed at CYYC for STRESS on 18 August. CYQF rawinsonde flights included training (04-18 June), STRESS support (18-20 Aug.) and inter-comparison experiments with our new upper air equipment. Operational soundings were discontinued at CYQF on 21 August. The mobile rawinsonde (MORAS) was used only for training and research operations (see CCOPE and STRESS summaries). A new TS-3A Airsonde system was also used for soundings during CCOPE and STRESS, with an additional TS-2A Airsonde unit borrowed from the University of Calgary for STRESS operations. The Airsonde units employ optical theodolites for wind data, calculations being coordinated with the thermodynamic data (for heights) through the Airsonde micro-processor.

The abandoned upper air soundings shown in table 1 were attributed to adverse weather conditions; i.e., strong surface winds in congested release areas, and ground equipment failure of the METOX equipment.

Despite personnel shortages, delays in ordering and delivering supplies, budget constraints, and introduction of new and unfamiliar equipment, 513 successful rawinsonde and Airsonde soundings were obtained during all 1981 field operations.

Table 1. Upper air release sites and equipment.

Flight Purpose	QF Metox	YC Metox	RM Metox	Moras RD65	QF 8022	ASD Airsondes	U of C Airsondes	Totals
Tests & Training	17	11		2		25		55
CCOPE 18 June - 08 July				44		36		80
STRESS 18 - 20 August	19	7	13	18		16	15	88
Hail Operations 20 June - 31 August	117	140						257
Intercomparison Tests	2			2	2	2		8
Totals	155	158	13	66	2	79	15	488
Abandoned Flights	3	2		1		2		8
Rejected Instruments	5	10				10	2	27

NEW SURFACE AND UPPER AIR EQUIPMENT

During 1981, the following new instrumentation systems were purchased:

1. four (4) automated portable weather stations (CR-21's) to record standard meteorological variables;
2. one (1) auto-tracking 1680 Mhz rawinsonde system to replace the aging Red Deer METOX equipment;
3. five (5) Airsonde upper air systems (TS-3A's) with automatic data reduction;
4. one (1) optical theodolite (Warren-Knight) modified for use with the TS-3A for semi-automated winds;
5. six (6) precision digital barometers.

These acquisitions represent a major milestone in research capability for the department, since a small scale network of up to 10 upper air sites (5 rawinsondes, 5 Airsondes) is now possible. While three of the older units must be phased out within the next year or two, plans are to make optimum use of all facilities in order to obtain a data base for energetics (scale interaction) studies during the next two years.

FORECASTING

Forecasting support for the summer field program was provided during the period 20 June to 31 August, 1981. As in previous years, a mini-briefing was held in the weather office at 09:00 MDT to provide an initial estimate of the day's convective potential. A more formal and complete forecast was incorporated into the daily operations planning meeting at 11:15 MDT each morning. The forecast included expected storm development areas, cloud bases and tops, motion, cloud seeding heights, and the forecast Convective Day Category (CDC), defined in table 2.

Table 2. Definition of AHP convective day Categories.

CDC	Intensity of Convective Weather
-3	No Deep Convection
-2	ACC, TCU, or CB
-1	Scattered showers
0	Widespread Showers
1	Pea or Shot
2	Grape
3	Walnut
4	Golfball
5	Larger than Golfball

The Synoptic Index Of Convection (S_C) was again used as an aid to forecast the CDC for the day. Furthermore, the valid S_C forecast period was extended from 36 to 48 hours, providing a complete second-day outlook.

Table 3. Forecast verification of convective day categories, 1981.

Observed CDC	-3	-2	-1	0	1	2	3	4	5	Totals
-3	2	2	2	0	0	0	0	0	0	6
-2	2	2	2	0	1	1	0	0	0	8
-1	0	2	3	3	1	0	1	0	0	10
0	0	1	1	7	1	1	2	1	0	14
1	0	2	0	0	4	2	2	0	1	11
2	0	0	0	0	3	9	2	3	0	17
3	0	0	0	0	0	2	2	0	0	4
4	0	0	0	0	0	0	0	2	0	2
5	0	0	0	0	0	0	1	0	0	1
Totals	4	9	8	10	10	15	10	6	1	73

Table 3 shows the forecast accuracy for the 1981 season, based on the forecaster's modification of the S_C index. Forecasts were correct to within one CDC category 73 per cent of the time, and 85 per cent correct in forecasting simply 'HAIL' or 'NO HAIL' (see table 4).

Table 4. HAIL/NO HAIL forecast verification, 1981.

Predictand (Observed)	Predictor (Forecast) No Hail	Predictor (Forecast) Hail
No hail	29	9
Hail	2	33

STORM FORECAST FIELD RESEARCH OPERATIONS

Two major field research operations, CCOPE and STRESS, were carried out by the Storm Forecast Group, with some manpower help provided by the Storm Environment Group.

CCOPE

During mid-June through mid-July, five staff members participated in the Cooperative Convective Precipitation Experiment (CCOPE) in southeastern Montana. The Storm Forecast Group's interest in CCOPE was primarily to obtain an upper air data base for scale interaction studies through energy budget analyses. CCOPE was a final field effort of the High Plains Experiment (HIPLEX), and was organized through the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. Two ASD upper air units, the mobile rawinsonde (MORAS) unit and a new Airsonde system (ADAS), were sited at Colstrip and Cohagen, respectively. These augmented five GMD-1 rawinsondes operated by Texas A and M University. All seven sites are indicated in Figure 3. A mutual exchange of data was agreed upon, including ASD use of surface data (125 automated stations within the network) and GOES satellite imagery.

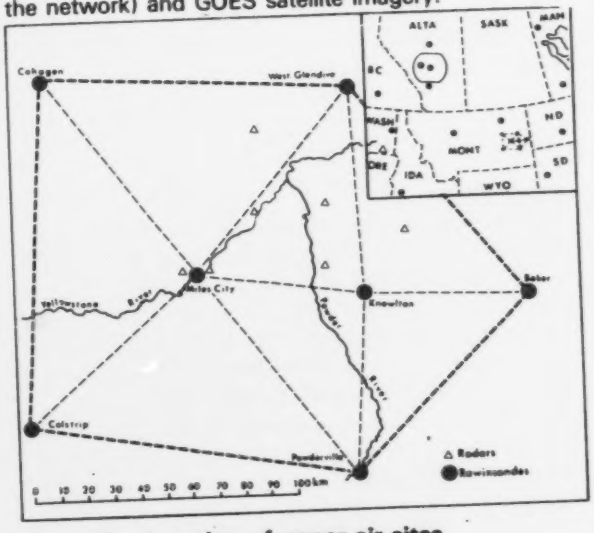


Figure 3. Location of upper air sites during CCOPE.

While the lack of a large, well-organized, severe storm during the CCOPE effort was disappointing, nine days of serial ascent data at all seven sites were obtained for small to medium storms. Thus, most of the scientific objectives for CCOPE participation were achieved. The venture also proved useful for developing international scientific contacts with experts in the same field, nurturing interest in and perhaps future participation in Alberta field studies, and obtaining experience with network logistics before implementing an Alberta network. In addition to scientific consultation, some contacts were also provided for rawinsonde data processing, error reduction, and analysis. Such aid is invaluable to any new research area. The energetics analyses are expected to contribute significantly to our understanding of the interactions between convective processes and larger scale atmospheric motions in Alberta and elsewhere.

STRESS

The extent to which current upper air systems can resolve subsynoptic and meso scale circulations associated with convective weather is still not clear. Since this question is crucial to any energetics data analysis, a three-day field operation for the Spatial and Temporal Resolution Study (STRESS) was carried out during 18-20 August.

Five upper air sites (3 rawinsondes, 2 Airsondes) released soundings at 1½ hour intervals and at 40-km spacings in straight lines. These lines were roughly normal to the upper air flow (Figure 4) so that maximum information on gradients could be obtained. The data will be used to determine the optimum (desirable minimum) network spacing of upper air sites for recording pressures, pressure heights, temperatures, moisture, and winds. Planned use of data from the new research aircraft to increase data resolution parallel to and normal to the lines was abandoned because of data recording problems. Hopefully, the aircraft data gap will be bridged during 1982.

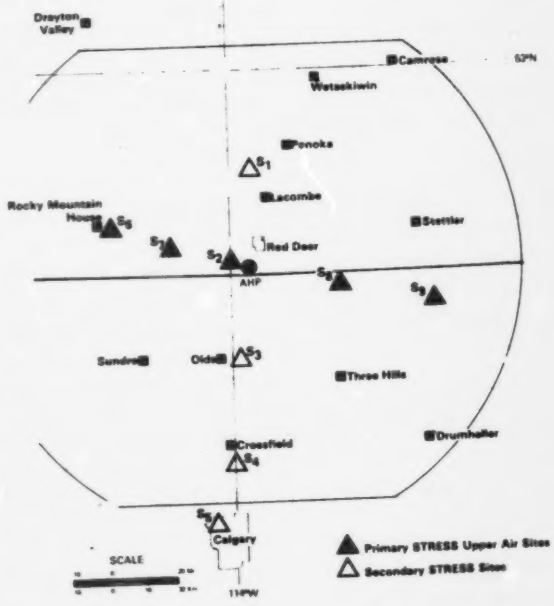


Figure 4. Location of upper air sites during STRESS.

The problems of comparative accuracy and resolution of different upper air sounding systems are part of the STRESS study. To this effort, several intercomparison tests between Airsondes and different rawinsonde systems were carried out, both during CCOPE and later at Red Deer. These culminated in a final test on 14 October involving an older METOX unit, the new auto-tracking rawinsonde, MORAS, one Airsonde system, and two PIBAL theodolites. Analysis of all STRESS data is now underway.

RADARS

As a result of deteriorating facilities, the radar complex was relocated to the north of, and adjacent to, the site of Building 29. This necessitated new tower bases for the C-band and X-band radars as well as a tower extension for the X-band antenna. All radar related electronic equipments were installed into a double wide ATCO enclosure located to the NE of the three (3) radar towers.

The aircraft PPI control facility was reconfigured into a console layout and relocated into Building 38.

The separation of the radar electronics into a radar site and a display center, necessitated the installation of a radar data remoting system. The purchase of a multi-fibre fibre-optic cable, support electronics, computer I/O port multiplexors, modems, and radar data multiplexors allowed for the assembling of a state-of-the-art remoting system which operated well throughout the season. The three project radar receiver systems are depicted in Figure 5.

S-BAND

The evaluation of the magnetron performed by Varian Associates following the 1980 field program proved that the tube had been electronically damaged. A repair order was issued and the repaired tube returned in mid-June. However, following installation and performance evaluation by a team of ASD personnel and Varian experts, it was agreed to shut the system down and await a redesign of the magnetron's support electronics, in particular, the pulse forming network and pulse filament transformer. With support from Varian and EEC, a new PFN and pulse package should be installed in time for the 1982 field program.

Through a subsidiary of a German company in Vancouver, B.C., a new main bearing for the antenna system was obtained. This was installed along with considerable refurbishing of the mechanical drive system. By mid-August, the antenna system was operating and fully controllable from the new radar facility. To complete the system, the old AN/TPRS, 502 S-band Transmitter was successfully reactivated. Thus during the latter part of August and the first part of September, S-band data was collected either singly or in conjunction with C-band data. S-band/C-band antenna slaving was not electronically available.

Recorded S-band data totalled 75.6 hours.

C-BAND

This radar system was the main source of radar data throughout the field program. After installing a new magnetron in the month of May, the transmitter/receiver operated without a fault.

The slip ring assembly inside the antenna pedestal suffered a catastrophic failure in mid-July; by using old and used parts, however, the system was partially available within 6 hours. Through refurbishing of used parts, the system was returned to full service within 3 days, and operated without difficulty for the remainder of the field program.

This system, operating in a 24 hour available basis with nightly calibration, totalled 970.5 hours of operation.

X-BAND

During the winter months the X-band antenna was refurbished by the U. of A. and then sent to NRC, Ottawa, for pattern evaluation and gain measurements. By utilizing a 3 mil mylar face cover, it was possible to reduce the Voltage Standing Wave Ratio to less than 1.5, thus enabling the transmitter to operate into it. Following the repair of two transponder sets, the total system, operating at half power as a result of a low power rotary joint and a high antenna V.S.W.R., operated flawlessly throughout the field program.

The system operated for 367 hours.

COMMUNICATION

With the assistance of Alberta Housing and Public Works, the field site communications system of AM and FM radios was completely rebuilt. Both systems are now provided by AHPW through a leasing agreement with the manufacturers. The AM system was expanded to three (3) channels using state-of-the-art transceivers with automatic battery backup, while the FM system was reconfigured to utilize two (2) repeater sites for better project area coverage.

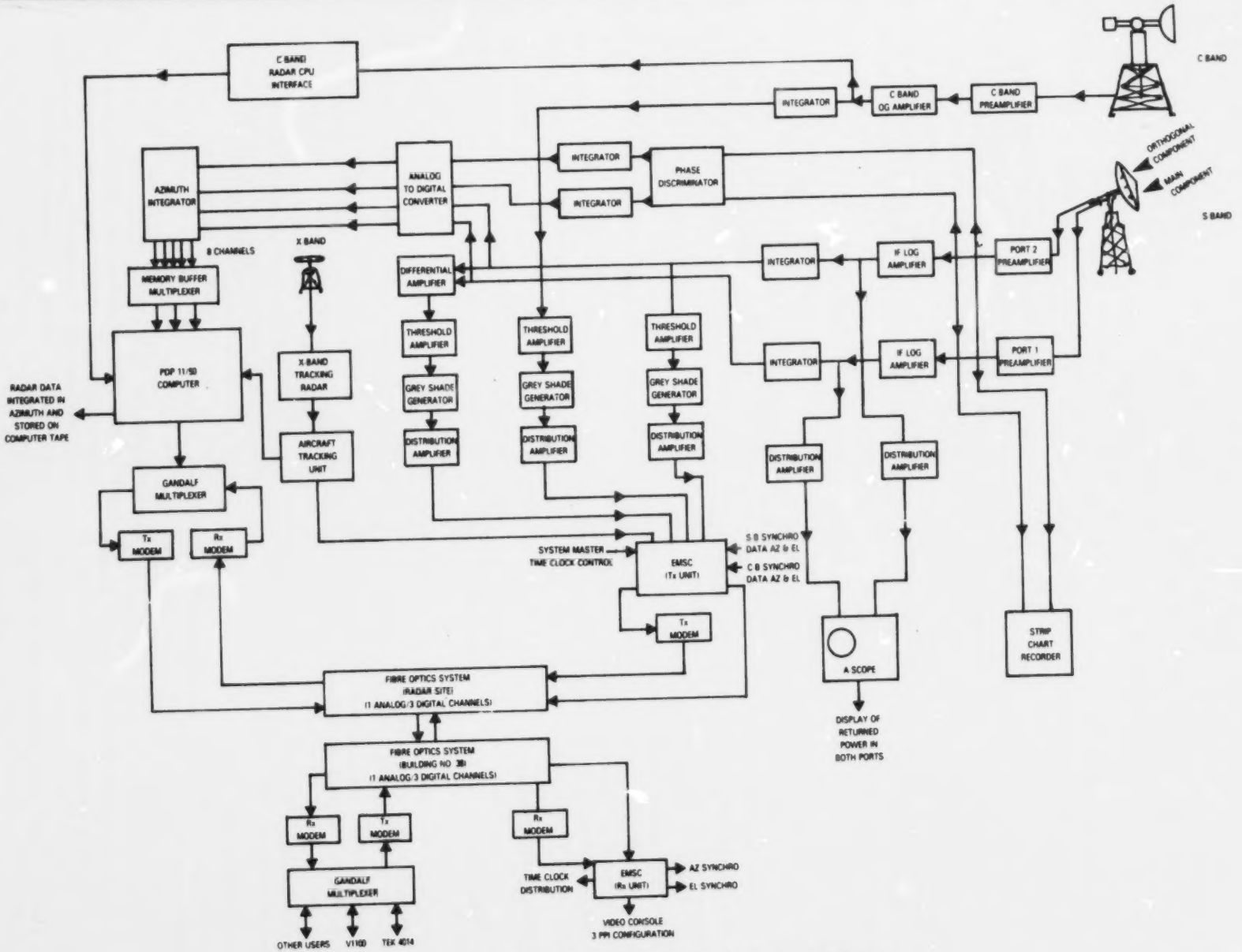


Figure 5. Simplified block diagram of the radar receivers.

COMPUTERS

COMPUTER HARDWARE

The computer was relocated, along with the radar electronic equipment, into the ATCO enclosure. At the end of May, a new C-band radar interface was installed. The interface, which was manufactured by Athabasca Research Corporation, was tested in early June. Some minor problems were found and corrected by a team of technicians consisting of Athabasca Research Corporation and ASD personnel. The unit performed flawlessly for the rest of the summer.

At the beginning of June, the computer hardware was upgraded to allow the PDP 11/34 computer in Penhold to be connected to the Alberta Research Council computer network. Occasional noise on the line which connects the computer to the network caused some minor problems.

During the summer, two terminal ports out of nine developed an intermittent fault and one of the tape drives malfunctioned once. All of these problems were remedied quickly and the data collected was not affected in any way.

To assist the aircraft controllers in the evaluation of seeding missions, a unit to produce paper copies of the computer graphics display was rented. The unit produced about 1200 copies during the operational period.

COMPUTER SOFTWARE

In 1981, the C-band data recording programs and the C-band calibration programs were modified to make use of the new C-band radar interface.

New software was introduced to allow the computer to communicate with other computers in the Alberta Research Council computer network. Extensions to the computer command language insured correct operation of the new software and prevented overloading of the computer.

All other software from 1980 was run without modification during the 1981 field season.

OPERATIONS PENHOLD

During the operational period, data was recorded onto computer tape whenever any storm was in the project area. The reliability of the hardware and software this year allowed data recording to continue for however long storms lasted. On several occasions, recording sessions lasted in excess of 30 hours, the longest one being 44 hours.

Four channel S-band data were recorded on 73 tapes representing 75.6 hours on 14 days.

One channel C-band data were recorded on 209 tapes representing 680.3 hours on 56 days.

The daily radar and computer tape logs are listed in Appendix 3.

To assist the dual wavelength experiments (the antennas were not synchronized in azimuth or elevation), all S-band and C-band data, when recorded simultaneously, were recorded on separate tapes. The tapes were transferred to Edmonton whenever department personnel travelled from Penhold to Edmonton. All other data was transferred automatically at 01:00 hours to Edmonton via the computer network.

OPERATIONS EDMONTON

Computer logs, transferred during the night, were printed every morning, thereby keeping personnel in Edmonton informed about the previous day's activity. Calibration data from the previous day was also plotted in the morning, checked, and processed. The processed calibration data was then used by programs in Edmonton and Penhold. All tapes arriving in Edmonton were registered and a summary program was run on each tape. The program produced one low resolution reflectivity plot for every half hour of recorded data.

Thus, as a result of the computer network, quality control was improved and data was ready for analysis as soon as the tapes arrived in Edmonton.

PRECIPITATION MEASUREMENT NETWORK

A volunteer operated precipitation measuring network of 562 stations was established over a 33,700 km² area (Figure 6) to collect daily rainfall measurements. The network was set-up in May and maintained from 1 June to 1 September. Seventy-seven percent of the station operators returned completed rainfall records for the three months. The precipitation maps for June, July, August, and the three month cumulative totals are presented in Appendix 4. The large precipitation amounts observed in July are from rain storms occurring during the passage of a "cold low" system through the area near the end of the month. The precipitation amounts in July dominate the cumulative totals, with most of the greatest depths occurring in the northern part of the project area.

All volunteer stations were supplied with a wedge-type rain gauge, color coded monthly rain records, envelopes for returning the records and a folder for storing the supplies and instructions. All station operators were instructed to record the amount of precipitation noted in the rain gauge at 08:00 MDT each day.

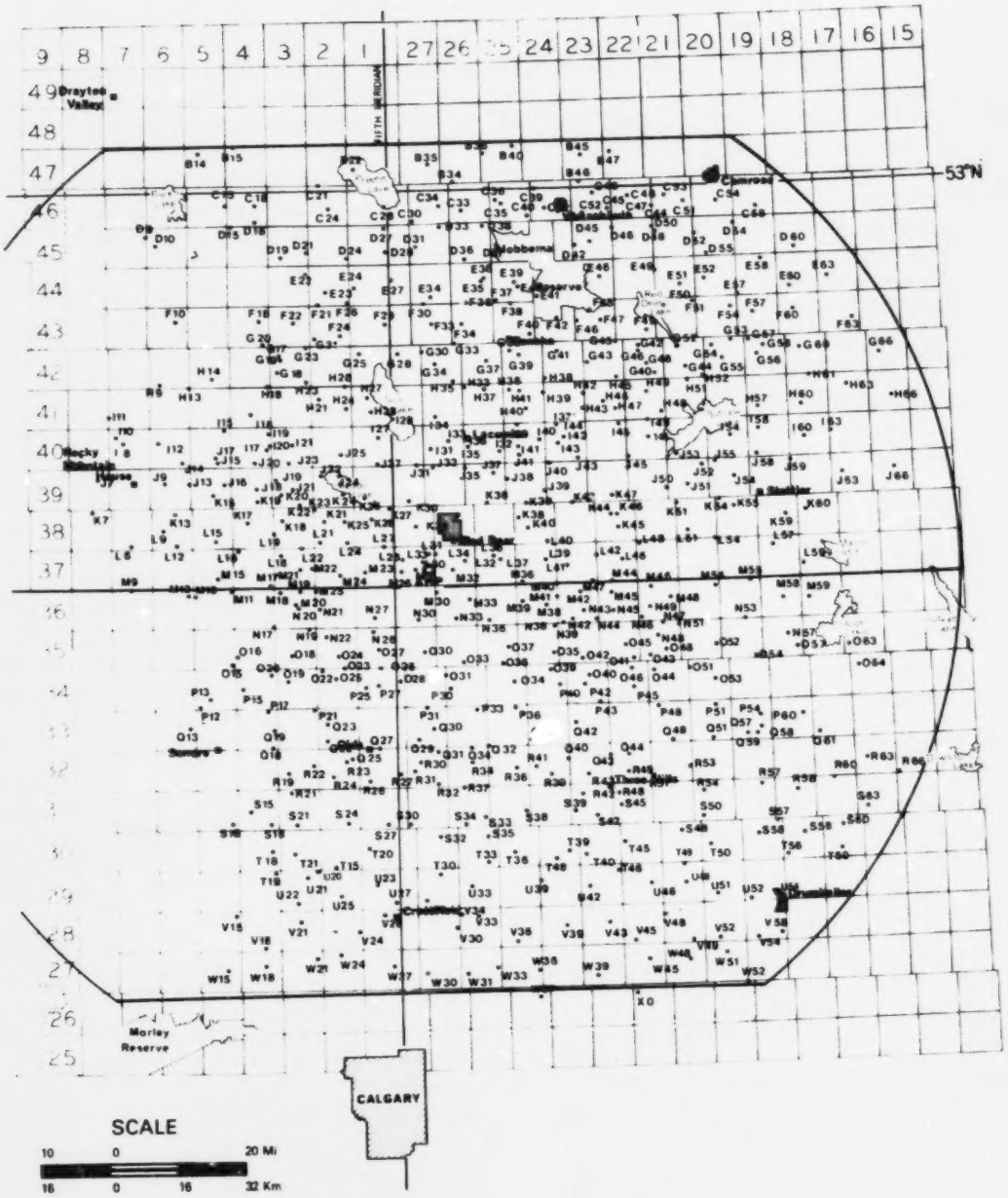


Figure 6. Precipitation measuring network operation by volunteers, 1981. The network consisted of 562 stations within a 33,700 km² area.

STORM CHASE

A storm chase program was operated during the period 6 July to 21 August, 1981. The primary objective of the program was to obtain measurements for the physical assessment and inadvertent weather modification projects. Three instrumented vehicles were directed underneath the high reflectivity zones of hail storms, using the Alberta Research Council's weather radar and radio communications system, to obtain sequential, time-resolved hailstone samples, hailpad measurements and rain samples. The hailstones collected were quenched in heptane at dry ice temperature to preserve the crystal structure. The hail samples and hailpads give the changes with time in the size distribution, axial ratio, internal structure, embryo type, isotope content and chemical composition of hailstones. From the rain samples, the chemical composition of rain is obtained.

During the program period, 64 rain samples (from 10 storm days), 49 time-resolved hail samples and 29 hailpads (from 5 hail days) were obtained (see table 5.).

Table 5. Summary of precipitation samples collected in 1981.

Date	Mobile Samples					Volunteer Samples	
	Sequential Hail Samples	Rain Samples	Ground* Samples	Hailpads	Size	Number	Size
July 13						4	Shot-pea
July 14		4				8	Shot-walnut
July 17						1	Shot
July 19	12	4			Shot-pea	7	Pea-grape
July 20	1	20		10	Shot	7	Shot-pea
July 27		3				3	Shot-grape
July 28						18	Pea-golfball
July 29	2	5	2	2	Shot-pea	1	Grape
August 1		3				1	Pea
August 3		5				4	Pea-grape
August 14						2	Pea
August 15		2					
August 16		1					
August 17	12	10	8	3	Pea-grape	2	Shot-pea
August 18	22	7	2	14	Shot-walnut		
Total	49	64	12	29		58	

*Time-integrated samples picked up from the ground by chase crews

To supplement the samples obtained from the chase vehicles, a volunteer network was established to collect time-integrated hailstone samples from the ground. Within the project area, 718 volunteers agreed to collect hailstones in their area. These samples were picked up from the volunteers by the chase crews on no-hail days. In total, 58 samples (from 10 different hail days) were obtained from the volunteers. These samples will be analyzed for isotope content, crystal structure and embryo type.

The various analyses of the precipitation samples are being carried out by staff of the Atmospheric Sciences and Chemistry Departments of the Alberta Research Council and the Geography and Physics Departments of the University of Alberta.

SINGLE STORM SEEDING EXPERIMENTS

Single storm seeding experiments are to be the major thrust of the physical assessment project. The main purpose of these experiments is to seed individual cloud turrets in the new growth zone of hailstorms and then follow the precipitation particles from these turrets through the main storm to the ground. The turrets themselves are to be investigated through cloud physics research aircraft penetrations, while the precipitation particles from a particular turret are to be followed through the main storm by radar and sampled by chase vehicles on the surface. Since the radar operates continuously, data gathering for the single storm seeding experiments can be divided into two components:

a) Cloud physics research aircraft penetrations
and
b) Storm chase

During the summer of 1981, data gathering for single storm seeding experiments was essentially exploratory, with no seeding experiments carried out. However, some practice in aircraft penetrations and storm chasing was obtained

RESEARCH AIRCRAFT CUMULUS PENETRATIONS

A total of 2 hrs 46 min of flight time was expended by the research aircraft in cumulus penetrations. These cumulus penetrations took place on 3 days: 30 July, 21 August, and 29 August. Some 2D-C and 2D-P images were recorded, but it is not possible to determine concentrations since no thermodynamic, dynamic, nor position data were recorded. Thus, virtually no cloud physics aircraft data was collected for the physical assessment project.

1981 RESEARCH AIRCRAFT OPERATIONS

The 1981 field season marked the arrival of the Cessna 441 Conquest airborne laboratory, developed under a new contract between the Alberta Research Council and INTERA Environmental Consultants. The research aircraft arrived at the Red Deer airport on July 16 after completing the required MOT flight tests. The Conquest is shown in Figure 7 and the instrumentation onboard is listed in table 6. A DEC VAX-11/750 computer with magnetic tape drive and printer-plotter was installed at the field site in late August to provide support for the data analysis.

Table 6. Research aircraft instrumentation.

Atmospheric State Parameters
- Rosemount Model 102 U2U Total Temperature Probe
- NCAR Reverse Flow Temperature Probe
- E.G. & G. Model 137-C3 Dew Point Temperature Probe
- Setra Systems Model 270 Pressure Transducers
- Setra Systems Model 271 Pressure Transducers
- Ball Engineering Model EX-410 Pressure Transducers
- Ball Engineering Model EX-210 B Differential Pressure Transducers

Atmospheric Microphysical Parameters
- PMS Forward Scattering Spectrometer Probe (FSSP)
- PMS Optical Array Spectrometer Probe Model OAP-2D-C, with Phase Discrimination
- PMS Optical Array Spectrometer Probe Model OAP-2D-P
- SPEC Ice Particle Counter Model IPC
- J-W Liquid Water Content (LWC) Meter
- INTERA Isokinetic Aerosol Sampling Manifold (IASM)
- Bendix Model RDR 1100 Digital Weather Radar

Cloud Dynamics Instrumentation
- Litton Inertial Navigation System Model LTN-76
- Rosemount Model 858 AJ Flow Angle Sensor
- INTERA Gust Probe System

Data Acquisition System
- Sensor Data Wiring System
- Signal Conditioning Unit
- PMS DAS-2D-64

Table 7 summarizes the flights according to projects and table 8 lists the individual flight dates, times of take-off and landing with location (QF-Red Deer, QL-Lethbridge, YC-Calgary), and flight descriptions. The aircraft did not operate from August 11 to 17 due to an engine fuel control unit failure.

Table 7. Research aircraft project flight summary.

Ground Generator Study	25.4 hours
STRESS	7.0
Instrument Calibration	7.1
Cumulus Penetrations	1.1
Aircraft Flow-Field Study	2.2
Storm Inflow Study	1.1
Total Flight Time:	43.9

Figure 7. The cloud physics research aircraft. This high performance, turbo prop aircraft is manufactured by Cessna, and is commonly called a "Conquest 441."

Table 8. Daily summary of 1981 research aircraft flights.

No.	Date	Take-Off	Landing	Duration Hours	Description
1	July 25	1430 (QF)	1730 (QF)	3.0	Ground Generator Study
2A	July 26	1517 (QF)	1707 (QL)	1.8	Ground Generator Study
2B	July 26	1819 (QL)	1926 (QF)	1.1	Ground Generator Study
3	July 27	1640 (QF)	1922 (QF)	2.7	Ground Generator Study
4A	July 30	1724 (QF)	1818 (YC)	.9	Ground Generator Study
4B	July 30	2001 (YC)	2038 (QF)	.6	Cumulus Penetrations
5A	July 31	1623 (QF)	1718 (QL)	.9	Ground Generator Study
5B	July 31	1840 (QL)	2018 (QF)	1.6	Ground Generator Study
6	Aug. 3	1609 (QF)	1714 (QF)	1.1	Storm Inflow Study
7A	Aug. 5	1455 (QF)	1555 (QL)	.5 .5	Instrument Calibration Ground Generator Study
7B	Aug. 5	1701 (QL)	1831 (QF)	.5 1.0	Ground Generator Study Instrument Calibration
8A	Aug. 10	1253 (QF)	1344 (QF)	.9	Instrument Calibration
8B	Aug. 10	1430 (QF)	1445 (QF)	.3	Instrument Calibration-Aborted
9A	Aug. 18	1248 (QF)	1401 (QF)	1.2	Instrument Calibration
9B	Aug. 18	1451 (QF)	1737 (QF)	2.8	Ground Generator Study
10A	Aug. 19	1242 (QF)	1325 (QF)	.7	Instrument Calibration
10B	Aug. 19	1839 (QF)	2330 (QF)	2.9 2.0	STRESS Study Ground Generator Study
11A	Aug. 20	1137 (QF)	1545 (QF)	4.1	STRESS Study
11B	Aug. 20	1813 (QF)	2052 (QF)	2.7	Ground Generator Study
12A	Aug. 21	0838 (QF)	1107 (QF)	2.5	Ground Generator Study
12B	Aug. 21	1623 (QF)	1848 (YC)	2.4	Ground Generator Study
12C	Aug. 21	1926 (YC)	1956 (QF)	.5	Cumulus Penetrations
13	Aug. 23	1138 (QF)	1224 (QF)	.8	Instrument Calibration
14	Aug. 24	0813 (QF)	1024 (QF)	2.2	Aircraft Flow-Field Study
15	Aug. 29	1452 (QF)	1631 (QF)	1.7	Instrument Calibration

Although over 43 hours of flight time were logged, the aircraft data system was never fully operational. The thermodynamics, dynamics, and microphysics instrumentation was installed but not calibrated. Approximately half of the data recorded has subsequently been found to be unreadable due to a tape drive problem on the aircraft. Some cloud hydrometer images recorded during one flight were plotted to verify the operation of the PMS 2-D probes.

The 1981 season can best be described as a year of development for the research aircraft.

GROUND GENERATOR ASSESSMENT PROGRAM

During early 1981, the Alberta Research Council was asked by Alberta Agriculture to evaluate the I.P. Krick weather modification technique. This technique uses ground-based silver iodide generators of the coke and arc types. A contract was signed with I.P. Krick Associates of Canada, Ltd. authorizing the operation of as many as 70 coke and 15 arc generators to deliver silver iodide artificial nuclei to a Target Area southeast of Calgary (Figure 8). The operational objective of the Krick company was to suppress hail and increase rainfall in the Target Area. The research objective of the Research Council was to assess the ability of the Krick system to generate and deliver ground generator effluent to prescribed target volumes in the atmosphere. This program of operations and research, designated the Ground Generator Assessment Program (GGAP), operated in the field from 20 June through 21 August inclusive.

Figure 8. I.P. Krick Associates target area for 1981 GGAP field program.

To meet the operational and research objectives of GGAP, it was necessary to conduct day-to-day operations of the Krick system, to monitor generator network operations, to conduct laboratory tests of generators, and to obtain in situ measurements of ice nuclei concentrations.

A summary of the daily network operations is given in the contractor's final report (see Bibliography).

The Research Council monitoring program consisted of visits to generator sites (Figure 9) to verify their operational status and collect generator fuel samples. The Colorado State University Cloud and Aerosol Simulation Laboratory performed tests of generator effectiveness and rates of nucleation using generators provided by the Krick company. Research Council personnel transported two coke generators and the Krick Palm Springs, office shipped an arc generator to Ft. Collins, Colorado for these tests. Results of these tests are given in the Colorado State University final report to the Alberta Research Council (see Bibliography). In situ measurements were made using a Colorado State University Mee ice nucleus counter mounted onboard the INTERA/ARC Atmospheric Sciences Research Aircraft (see section on Research Aircraft Operations). Results of the monitoring and in situ measurement programs are detailed in the Alberta Research Council final report to Alberta Agriculture (see Bibliography).

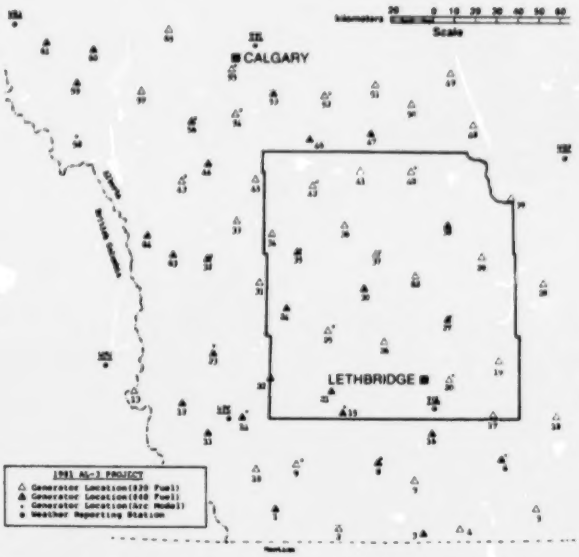


Figure 9. Ground-based silver iodide generator sites for 1981 GGAP field program.

CLOUD SEEDING OPERATIONS 1981

INTRODUCTION

The scope of the cloud seeding operations in 1981 was similar to that of previous years (see 1978-1980 Field Program Reports). However, there were several notable changes in the details of the operations, including:

a) reduced aircraft complement,
b) reduced length of the operational seeding period,
c) use of the acetone generator and pencil flare seeding systems,
d) the assignment of a full-time INTERA controller/meteorologist to Penhold, and
e) a new operations control facility.

OPERATIONS

INTERA Environmental Consultants Ltd. of Calgary was again awarded the cloud seeding contract, which called for six seeding aircraft rather than the seven that had been used in 1980. Studies of previous summers with seven seeding aircraft had indicated that the seventh aircraft was invariably underutilized, so the reduction to six aircraft was basically a move to increase the cost-effectiveness of the Hail Project. Similarly, since climatology indicates that hail is much less frequent in September than in June, July and August, the operational period ended August 31 rather than September 10 as in previous years. The number of personnel supplied by INTERA to carry out the cloud seeding operations was unchanged from 1980. However, for the first time, a radar controller/meteorologist is now assigned full-time at Penhold throughout the year under the joint supervision of the Atmospheric Sciences Department and INTERA. This person will be involved in exploratory studies concerning cloud seeding efficiency and logistics, along with his summertime operational duties.

LOGISTICS

The cloud seeding logistics were unchanged from previous years (see Barge et al, 1976, for details)[1]. There were, however, two new seeding material delivery systems used: acetone generators and 'pencil' flare systems. For cloud base seeding, three aircraft were equipped with acetone generators (two each) designed to burn a 2 per cent solution of AgI in acetone. The three remaining aircraft retained the 150 g end-burning flares, manufactured by Nuclei Engineering Inc. (TB1 formulation). Some technical problems were encountered with the acetone generators during the summer, including:

a) valves sticking shut or open and parts becoming covered with material precipitating from the acetone solution,
b) difficulties with pumps due to corrosion of rubber parts and seals by the acetone,
c) difficulties in handling the acetone because of its volatility and toxic fumes, and
d) finding a suitable pump and nozzle combination with sufficient control to transfer the acetone solution to the aircraft-mounted generators without spilling most of it. Progress was made during the summer in resolving these teething problems as more experience with the generators was gained.

For cloud top seeding, four aircraft were equipped with the old, reloadable flare system using NEI-TB1, 55 g AgI droppable flares. The remaining two aircraft were equipped with a new droppable 'pencil' flare system, using NEI-TB1, 20 g AgI flares. These 'pencil' flares are dropped along the storms' new growth regions every five seconds, compared to the drop rate of one every 20 seconds for the large top flares. This procedure should result in greater dispersion of seeding material into the storm.

FACILITIES

This year, the old, cramped operations building was finally abandoned with the relocation of the Hail Project operations to larger quarters in Building 38 on the Red Deer Airport. The new seeding control room measures roughly 9 x 6 m and is a vast improvement in comfort, space and quietness over the old control room. Figure 10 shows the new operations master control console installed in the control room. The console has 3 radar controller positions (only 2 were operational in 1981), a real-time computer display, a hard-copy printer, a video terminal and communications controls.

A room adjacent to the cloud seeding room houses a variety of new electronic equipment including:

a) 3, Wulfsberg (WCS-100) VHF radios with backup emergency battery power,
b) a 4 channel Dictaphone tape recorder with automatic tape change over, time hack and play-back features,
c) fibre optic equipment, to receive radar and computer data (via a fibre optic cable) from the radar site approximately 0.25 km away.

AIRCRAFT FLIGHTS AND FLARE USAGE SUMMARY

During the period June 15 to 19 inclusive, 20 missions (13.0 hours) were flown for training. Table 9 summarizes the number of seeding and patrol days in 1981. It shows that seeding missions occurred on 55 per cent of the project days, while seeding or patrol missions occurred on 74 per cent of the project days. The corresponding numbers for 1980 were 61 per cent (51/83 days) and 75 per cent (62/83 days) respectively.

Table 9. Summary of days with seeding or patrol flights during 1981.

	June 20 - June 30 Inclusive	July	August	June 20 - August 31 Inclusive (73 days)
Number of Days With Seeding	7	17	16	40
Number of Days With Patrol Only	1	7	6	14
Total Seeding Or Patrol	8	24	22	54

[1]Barge, B.L., F. Bergwall, G. Goyer and J. Renick, 1976: Fine scale structure of convective storms — implications for cloud seeding in Alberta. Atmospheric Sciences Department, Report 76-3, Alberta Research Council, Edmonton. 19 pp.

Table 10. Summary of 1981 aircraft cloud seeding operations: June 15 - August 31.

Aircraft Call Sign	Aircraft Type	Aircraft Registration	Total Missions	Total Hours	Pencil Flares Dropped	Large Top Flares Dropped	Base Flares Burned	Acetone Burned (Gallons)
HS1	PAZT	FHRA	44	85.3		363		61.2
HS2	C310	GBLB	83	154.5		726	492	
HS3	C310	GRKM	64	134.4		1051	161	59.3
HS4	C411	GELL	34	55.7	463		183	
HS5	C310	GRSJ	62	113.1		920		31.6
HS6	C340	N5405J	92	147.6	5285		163	
		TOTALS	379	690.6[1]	5748	3060[2]	999	152.1

Notes:
1. Seeding and patrol missions accounted for 576.4 hours of this total. The remainder went for training, ferry, test and flare pickup flights, along with missions in support of the NCAR counter in Lethbridge.
2. 2693 of these were 55 g AgI flares; 367 were 70 g AgI flares.

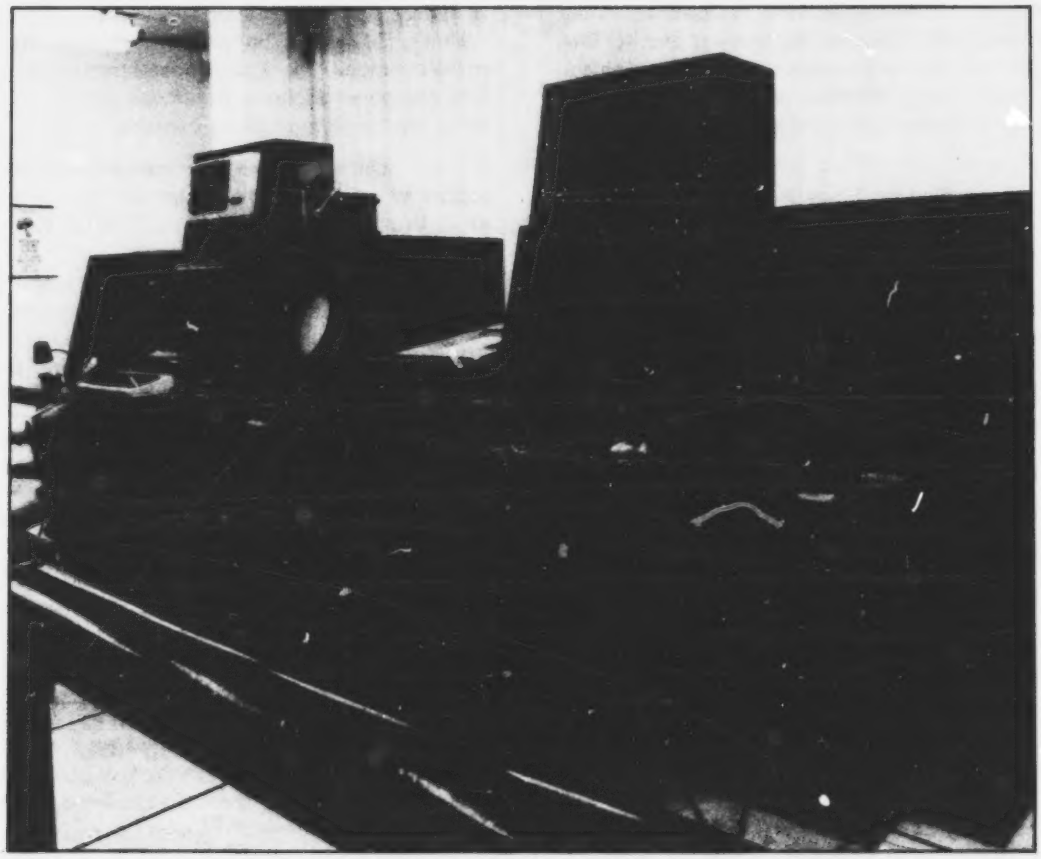


Figure 10. Radar controller's console. The console was designed in modular form to provide ease of maintenance and future expansion capability. The "blank" work station will be equipped similar to the other stations for use by a research co-ordinator or research aircraft mission director during the 1982 field program.

Table 10 summarizes the 1981 operations for each of the six seeding aircraft. The total number of missions (379) and total flying hours (690.6) are down from the 1980 totals of 419 and 1009.4 respectively.

DISCUSSION

The Atmospheric Sciences research program has seen a number of major changes and improvements over the past year. Those, with long term implications, include:

a) development of a major research aircraft facility,
b) new and renovated field facilities at Penhold,
c) revised cloud seeding guidelines and,
d) changes to the cloud seeding delivery systems for cloud top and base seeding.

For a number of years, project scientists have expressed a need for an airborne cloud physics research facility. Without access to in situ cloud physics data it was not possible to obtain definitive answers as to whether cloud seeding could modify the precipitation processes in Alberta clouds. In keeping with the Alberta Research Council's interest in working with industry to solve common problems, the Atmospheric Sciences Department developed (with INTERA) a research aircraft platform capable of making sophisticated cloud physics measurements. A major step has been taken, and in the succeeding years valuable data supporting numerous research projects will be obtained.

The project has operated out of facilities at the Red Deer Industrial Airport (formerly CFB Penhold) for over 25 years. As the scope of the project expanded and the facilities grew older, it finally became necessary to vacate the old "operations center" and move to alternate quarters. Planning began early in 1980 to move the facilities after the completion of the 1980 field season. The short range solution was to split the various field units. The "split" involved moving the radar operations unit into an Atco double wide portable building adjacent to the radars, with the operations control centre, weather and other operational support facilities moved to an existing building approximately 0.25 km south of the radars. Preliminary planning, possibly for a permanent project site somewhere in central Alberta, is now underway.

Since the beginning of the operational cloud seeding test in 1974, the seeding contractor has operated according to procedures given in the "Cloud Seeding Operational Guidelines". One of the weak points in the guidelines has been the section containing the seeding aircraft launch and seed criteria. Under the old guidelines, any cloud with a radar reflectivity of 35 dBZ or greater was to be seeded. This single criterion has a number of shortcomings. With increased operating costs, its use has become impractical from strictly an economic point of view. More important, however, the single seeding criterion did not reflect the advances made in thunderstorm research over the past few years.

The new guidelines for cloud seeding are based on a combination of the weather forecast S_c (see Meteorological Section), radar reflectivity and, in the event only C-band radar is available, cloud top height. The criteria for launching aircraft are shown in Figure 11. For example, if the forecast S_c is +3, aircraft need not be launched until a cloud reaches 30 dBZ.

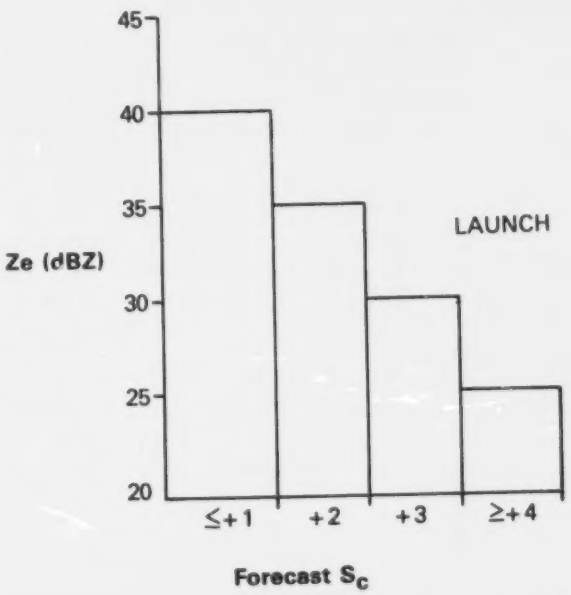


Figure 11. Criteria for launching cloud seeding aircraft. These criteria are based on the forecast S_c for the day and C or S-band radar reflectivity data. For example, if the forecast is +3 (walnut size hail), cloud seeding aircraft must be launched when a storm exceeds 30 dBZ.

Once an aircraft is launched, Figure 12 is used to determine cloud seeding. For this chart to be used, S-band radar data and corresponding CDR information must be available.

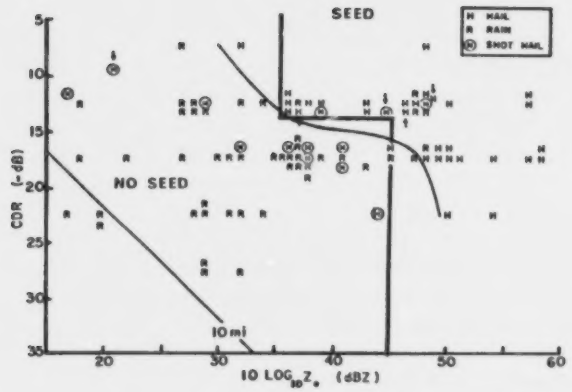


Figure 12. Primary seeding criteria. These criteria are based on a scatter diagram of surface rain and hail reports with corresponding values of the CDR and Z_e measured aloft (1-2° elevation) by the S-band radar (Barge, 1972)[2]. The curve in the center of the diagram separates rain and shot-size hail from larger hail and establishes the SEED/NO SEED criteria.

Should the S-band radar not be available, a secondary set of seeding criteria (Figure 13) are used, based on C-band reflectivity data and cloud top height.

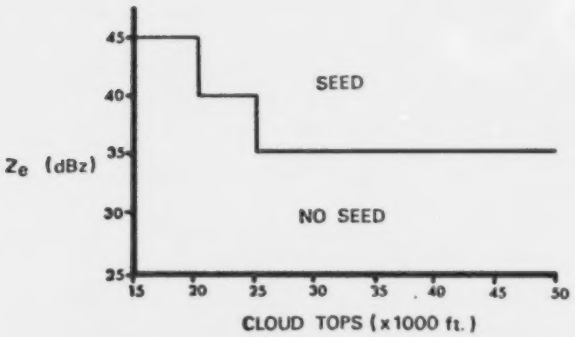


Figure 13. Secondary seeding criteria. These criteria are used when only the C-band radar is available. Any convective cloud with tops exceeding 25,000 ft. must be seeded when radar reflectivity reaches 35 dBZ.

Operations are suspended when any one of the criteria is not met for a period of 15 minutes.

Further refinements to the seeding guidelines are expected when the research aircraft data become available over the next few years.

As with the new seeding guidelines, the cloud seeding delivery systems for both cloud top and base seeding were changed on some aircraft this year. As mentioned in the 1980 Field Program Report, (Deibert, ed., 1982) acetone generators were tested during the 1980 season for possible inclusion into the 1981 program. Three aircraft were subsequently equipped with the acetone systems and operated throughout the 1981 season. Numerous problems in all areas of operation were noted, many caused by unfamiliarity with the equipment and improper procedures for mixing the solution. These problems and the lack of proper ground handling equipment must be corrected if continued use of acetone generators is anticipated.

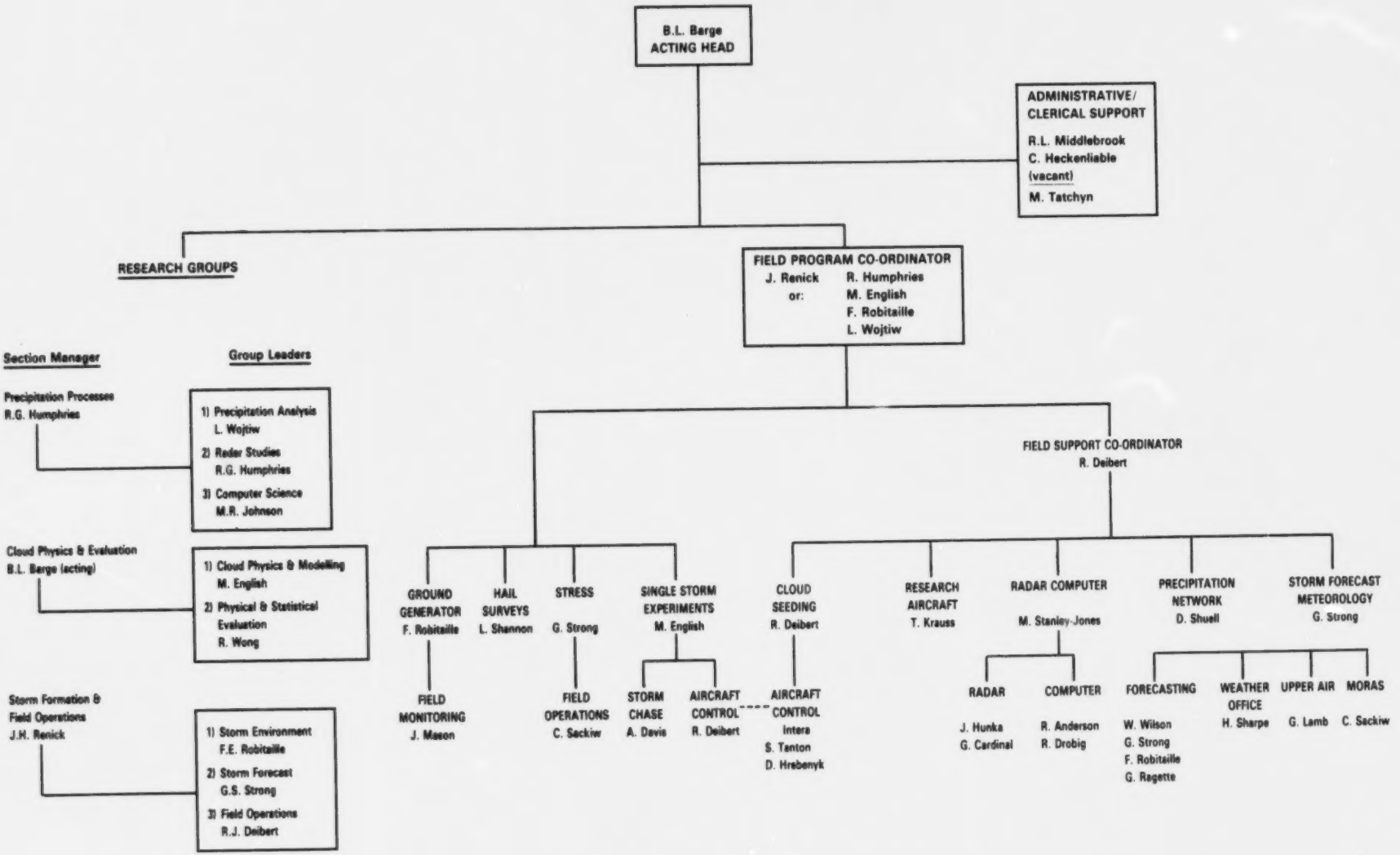
The cloud top seeding systems were changed on two aircraft. The older reloadable system which used 40 mm (diameter) ejectable flares was discarded in favor of a 400 unit, non-reloadable flare ejector rack which uses 20 mm (diameter) "pencil" flares. The spacing between flare releases was shortened in order to permit greater dispersion of the seeding material into the storm (see Cloud Seeding Section). No problems were encountered with either the rack or the new type flares.

The 1981 field program definitely had its "startup" problems. Many were related to late completion of facilities; others to equipment breakdown, both old and new. It is anticipated that most of these problems can be corrected prior to the start of the 1982 field program.

[2]Barge, B.L., 1972: Hail detection with a Polarization diversity radar. Stormy Weather Group, RPT. MW-71, Feb. 1972, McGill Univ., Montreal.

APPENDICES
1 to 7

APPENDIX 1. Atmospheric Sciences Department field program organization chart, 1981 and list of project personnel



APPENDIX 1. 1981 Atmospheric Sciences Program Personnel

Staff

Alberta Research Council (ASD)

Penhold

Mr. R. Anderson
Mr. R. Deibert
Ms. C. Heckenliable
Mr. G. Lamb
Ms. R. Middlebrook
Mr. J. Renick
Ms. L. Shannon
Mr. H. Sharpe
Mr. G. Strong
Mr. W. Wilson

Edmonton

Ms. S. Ackerman
Dr. B. Barge
Mr. R. Barlow
Mr. F. Bergwall
Mr. G. Cardinal
Dr. L. Cheng
Mr. N. Chidambaram
Mr. A. Davis
Mr. R. Drobig
Dr. M. English
Mr. C. Ewing
Mr. B. Folliott
Ms. M. Fong
Dr. G. Goyer
Ms. B. Henderson
Dr. I. Hsu
Dr. R. Humphries
Mr. J. Hunka
Mr. M. Johnson
Mr. D. Kenyon
Mr. B. Kochtubajda
Mr. B. Korendyk
Dr. T. Krauss
Mr. J. Mason
Ms. J. Moreau
Dr. G. Ragette
Dr. J. Ramsden
Ms. S. Richardson
Mr. F. Robitaille
Mr. C. Sackiw
Mr. M. Stanley-Jones
Ms. L. Stovel
Ms. M. Tatchyn
Mr. E. Torlaschi
Mr. L. Wojtiw
Mr. R. Wong

Summer Assistants

Mr. B. Bain
Mr. T. Bennett
Ms. B. Emard
Ms. C. Emard
Ms. K. Finstad
Mr. D. Fudger
Mr. P. Hopps
Mr. R. Kellow
Mr. C. Kelly
Ms. D. Klein
Ms. C. Klepacz
Mr. B. Lake
Mr. P. Quesnel
Mr. B. Sellers
Mr. D. Shuell
Ms. L. Stollings
Ms. S. Tekelenburg
Mr. L. Thurber
Ms. C. Wahl
Mr. G. Warnke
Mr. M. Waszkiewicz
Mr. B. White
Mr. J. Yee

Associated Participants

INTERA Environmental Consultants Ltd.

Mr. L. Baker
Mr. M. Bersier
Mr. P. Boyd
Mr. B. Bullock
Mr. M. Bullock
Mr. P. Dodd
Mr. R. Gantner
Mr. B. Gelhorn
Mr. P. Gibson
Mr. K. Grandia
Mr. P. Grimsey
Mr. S. Grisbrook
Mr. J. Hamilton
Ms. E. Haworth
Mr. D. Henderson
Ms. S. Holliday
Mr. B. Hrebenyk
Mr. A. Kittleson
Mr. E. Leavitt
Mr. P. Lens
Mr. M. Olsekiw
Mr. A. Ross
Mr. R. Rudolph
Mr. D. Rumack
Mr. S. Slater
Mr. A. Stuart
Mr. S. Tanton
Mr. G. Toth
Mr. R. Thomson

APPENDIX 2. Summary of hail days and hail reports for June, July, August and September from 1974 - 1981.

Northern Area

Years	June	July	August	September	Total
		No. Hail Days/Month			
1981	19	14	9	2	44
1980	18	21	17	2	58
1979	17	18	8	7	50
1978	20	18	8	2	48
1977	13	17	14	3	47
1976	11	16	12	2	41
1975	16	13	15	5	49
1974	12	16	13	2	43
Avg. 197 81	16	17	12	3	48
Avg. 1957-81	13	15	9	2	39
		No. Hail Reports/Month			
1981	423	267	77	2	769
1980	93	939	492	2	1526
1979	315	993	211	157	1676
1978	537	820	227	12	1596
1977	207	426	257	192	1082
1976	307	733	526	8	1574
1975	207	1165	721	57	2150
1974	269	1153	298	7	1727
Avg. 1974-81	295	812	351	55	1513
Avg. 1957-81	338	747	317	25	1427

Southern Area

Years	June	July	August	September	Total
		No. Hail Days/Month			
1981	20	13	13	2	48
1980	16	18	19	3	56
1979	14	22	11	7	54
1978	13	16	7	5	41
1977	11	18	11	3	43
1976	8	13	10	1	32
1975	19	18	14	5	56
1974	10	10	12	1	33
Avg. 1974-81	14	16	12	3	45
Avg. 1957-81	12	15	9	2	38
		No. Hail Reports/Month			
1981	329	469	258	2	1058
1980	317	1013	151	92	1573
1979	84	633	162	290	1169
1978	458	425	55	15	953
1977	162	474	132	199	967
1976	76	295	329	36	736
1975	357	394	319	9	1079
1974	328	422	523	5	1278
Avg. 1974-81	264	516	241	81	1102
Avg. 1957-81	295	622	289	36	1242

Outside Project Area

Years	June	July	August	September	Total
		No. Hail Days/Month			
1981	21	18	14	2	55
1980	27	22	23	4	76
1979	21	20	15	6	62
1978	16	24	16	8	64
1977	22	25	18	4	69
1976	16	19	15	4	54
1975	25	17	18	7	67
1974	16	25	18	3	62
Avg. 1974-81	21	21	17	5	64
		No. Hail Reports/Month			
1981	177	97	77	2	353
1980	200	153	116	14	483
1979	172	169	100	31	472
1978	379	177	96	53	705
1977	143	207	153	81	584
1976	193	174	203	8	578
1975	244	332	262	28	866
1974	178	559	75	8	820
Avg. 1974-81	211	234	135	28	608

Combined Northern and Southern Areas

Years	June	July	August	September	Total
		No. Hail Days/Month			
1981	23	16	15	3	57
1980	20	23	23	3	69
1979	18	24	14	7	63
1978	20	23	10	5	58
1977	18	22	16	3	59
1976	12	18	15	3	48
1975	23	20	18	6	67
1974	12	17	15	2	46
Avg. 1974-81	18	20	16	4	58
Avg. 1957-81	15	18	12	2	47
		No. Hail Reports/Month			
1981	752	736	335	4	1827
1980	410	1952	641	94	3099
1979	399	1626	373	447	2845
1978	995	1245	282	27	2549
1977	369	900	389	391	2049
1976	383	1028	855	44	2310
1975	564	1559	1040	66	3229
1974	597	1575	821	12	3005
Avg. 1974-81	559	1328	592	136	2614
Avg. 1957-81	633	1368	607	61	2669

Number Of Hail Reports For Northern Area

Date 1981	Maximum Size								
	Shot	Pea	Grape	Walnut	Golfball	>Golfball	Unknown	No Hail	Total
June 2	1	–	–	–	–	–	–	–	1
3	1	9	3	–	–	–	–	–	13
6	6	3	–	–	–	–	–	–	9
9	2	3	–	–	–	–	–	–	5
10	4	6	3	–	–	–	1	–	14
11	1	16	3	–	–	–	–	–	20
13	4	5	1	–	–	–	–	–	10
14	3	3	2	–	–	1	–	–	9
15	1	1	–	–	–	–	–	–	2
16	6	12	5	–	–	–	–	–	23
17	2	3	1	–	–	–	–	–	6
19	2	–	–	–	–	–	–	–	2
20	19	40	4	1	–	–	1	289	65
21	14	22	2	–	–	–	–	177	38
23	23	58	2	–	–	–	2	144	85
24	–	1	–	–	–	–	–	–	1
26	13	26	21	–	–	–	2	99	62
27	16	34	2	–	–	–	4	117	56
30	2	–	–	–	–	–	–	7	2
July 4	7	14	3	–	–	–	–	71	24
5	–	–	1	–	–	–	–	33	1
6	–	–	–	–	–	–	–	63	–
10	–	–	–	–	–	–	–	34	–
11	10	19	8	–	–	–	–	213	37
13	3	20	7	–	–	–	1	86	31
14	4	13	3	–	1	–	2	106	23
16	–	1	–	–	–	–	–	23	1
18	–	–	–	–	–	–	–	3	–
19	7	8	10	1	–	–	–	133	26
20	9	39	24	2	–	–	1	263	75
21	1	1	–	–	–	–	–	47	2
23	2	4	1	–	–	–	–	88	7
26	–	–	–	–	–	–	–	46	–
27	3	17	2	–	–	–	1	123	23
28	2	–	–	–	–	–	–	35	2
29	–	1	–	–	–	–	–	58	1
31	4	6	4	–	–	–	–	99	14
Aug. 1	3	7	2	–	–	–	–	118	12
2	8	4	6	–	–	–	–	96	18
3	4	2	–	–	–	–	–	84	6
4	3	6	1	1	–	–	–	46	11
5	–	–	–	–	–	–	–	38	–
8	–	–	–	–	–	–	–	2	–
12	–	3	–	–	–	–	–	94	3
14	1	3	2	–	–	–	–	104	6
15	–	–	–	–	–	–	–	13	–
16	–	–	–	–	–	–	–	4	–
18	1	3	–	–	–	–	–	30	4
19	2	2	–	–	–	–	–	33	4
20	–	–	–	–	–	–	–	6	–
21	3	8	2	–	–	–	–	149	13
Sept. 5	–	1	–	–	–	–	–	–	1
24	–	1	–	–	–	–	–	–	1

Number Of Hail Reports For Southern Area

Date 1981	Maximum Size								
	Shot	Pea	Grape	Walnut	Golfball	>Golfball	Unknown	No Hail	Total
June 3	—	1	—	—	—	—	—	—	1
4	3	1	1	—	—	—	—	—	5
6	3	14	6	1	—	—	—	—	24
7	—	1	—	—	—	—	—	—	1
8	3	—	3	—	—	—	—	—	6
9	2	1	—	—	—	—	1	—	4
10	3	7	2	1	—	—	3	—	16
11	2	2	2	—	—	—	—	—	6
12	1	—	—	—	—	—	—	—	1
13	4	3	—	—	—	—	—	—	7
14	—	2	1	—	—	—	1	—	4
15	—	1	1	—	—	—	—	—	2
16	2	5	2	1	—	—	—	—	10
17	3	6	—	1	—	—	1	—	11
20	1	—	—	—	—	—	—	—	1
21	11	7	—	—	—	—	—	137	18
23	31	62	7	—	—	—	3	167	103
26	21	41	37	—	—	—	3	162	102
27	4	2	—	—	—	—	—	23	6
30	—	—	—	—	—	—	1	7	1
July 5	1	—	—	—	—	—	—	22	1
6	—	—	—	—	—	—	—	58	—
9	—	—	—	—	—	—	—	16	—
10	—	1	—	—	—	—	—	—	1
11	1	1	—	—	—	—	1	12	3
13	—	2	—	—	—	—	—	35	2
14	18	26	8	1	1	—	7	170	61
16	—	—	—	—	—	—	—	13	—
18	1	2	—	—	—	—	—	18	3
19	11	23	30	16	3	—	2	237	85
20	8	18	20	2	—	—	—	205	48
21	—	—	—	—	—	—	—	22	—
23	1	—	—	—	—	—	—	81	1
27	5	30	13	—	—	—	—	104	49
28	11	25	28	32	21	5	—	160	122
29	26	43	16	3	1	—	1	278	90
31	—	2	1	—	—	—	—	22	3
Aug. 1	—	2	1	—	—	—	—	33	3
2	1	1	—	—	—	—	—	21	2
3	7	23	22	—	—	—	1	205	53
4	6	23	5	—	—	—	—	101	34
5	—	—	—	—	—	—	—	6	—
7	2	3	1	—	—	—	—	7	6
11	—	—	—	—	—	—	—	4	—
12	—	—	—	—	—	—	—	57	—
14	1	5	3	—	—	—	—	46	9
15	4	15	20	6	1	—	1	102	47
16	—	2	3	—	—	—	—	120	5
17	9	37	23	2	—	—	—	252	71
18	1	2	1	1	—	—	—	8	5
20	1	3	—	—	—	—	2	86	6
21	2	11	3	—	—	—	—	184	16
26	—	—	1	—	—	—	—	—	1
Sept. 5	—	—	1	—	—	—	—	—	1
22	—	—	1	—	—	—	—	—	1

Number Of Hail Reports For Outside Project Area

Maximum Size

Date 1981	Shot	Pea	Grape	Walnut	Golfball	>Golfball	Unknown	No Hail	Total
June 3	3	8	3	—	—	—	1	—	15
4	—	3	—	—	—	—	—	—	3
6	3	6	3	—	—	—	—	—	12
9	4	6	4	—	—	—	1	—	15
10	4	19	5	—	—	1	1	—	30
11	4	10	1	—	—	—	—	—	15
12	2	4	1	—	—	—	—	—	7
13	1	1	—	—	—	—	—	—	2
14	3	4	1	—	—	—	—	—	8
15	2	5	—	—	—	—	—	—	7
16	—	3	1	—	—	—	—	—	4
17	5	9	3	—	—	—	3	—	20
18	2	1	1	—	—	—	—	—	4
19	—	—	1	—	—	—	—	—	1
20	—	3	3	—	1	—	—	—	7
21	1	4	—	—	—	—	—	—	5
22	—	—	1	—	—	—	—	—	1
23	2	7	3	1	—	—	—	—	13
24	1	—	—	—	—	—	—	—	1
26	—	1	—	—	—	—	—	—	1
27	2	4	—	—	—	—	—	3	6
July 1	1	1	2	—	—	—	—	—	4
7	—	—	3	2	—	—	—	—	5
11	1	3	—	—	—	—	—	—	4
12	—	—	1	—	—	—	—	—	1
13	1	9	2	3	1	—	—	—	16
14	1	—	2	—	—	—	—	—	3
15	—	4	1	1	—	—	—	—	6
16	—	1	1	—	—	—	—	—	2
17	—	1	1	—	—	—	—	—	2
18	—	—	—	1	—	—	—	—	1
19	1	1	2	1	—	—	—	1	5
20	—	1	2	1	—	—	—	4	4
21	—	4	—	—	—	—	—	3	4
22	—	1	—	—	—	—	—	—	1
28	—	2	3	10	1	1	—	—	17
29	1	5	1	5	3	—	—	2	15
30	—	1	—	—	—	—	—	—	1
31	—	5	1	—	—	—	—	—	6
Aug. 1	—	2	1	—	—	—	—	—	3
3	—	8	3	4	—	—	—	4	15
4	2	5	8	1	—	—	—	16	16
10	1	—	—	—	—	—	—	—	1
12	—	2	—	—	—	—	—	—	2
14	—	—	—	—	—	—	—	3	—
15	—	2	2	1	—	—	—	—	5
17	1	6	6	4	—	—	1	8	18
18	—	3	—	—	—	—	—	—	3
19	—	1	—	—	—	—	—	—	1
20	—	—	—	2	—	—	—	—	2
21	—	1	—	—	—	—	—	3	1
25	1	1	—	—	—	—	—	—	2
26	—	2	—	1	—	—	—	—	3
27	—	1	3	1	—	—	—	—	5
Sept. 23	1	—	—	—	—	—	—	—	1
24	—	—	1	—	—	—	—	—	1

L P C 2

Storm Date ..... 1981 Day of Week: .....

Location ..... ¼ S ..... T ..... R ..... W of .....

Hail:

Began — AM ..... / PM .....

Lasted for ..... minutes

Storm approached from .....

Rain: none ◯

Began — AM ..... / PM .....

Lasted for ..... minutes

Measured ..... mm

Estimated ..... mm

Hail Size:	Snot	Pea	Grape	Walnut	Golfball	Larger
Largest	◯	◯	◯	◯	◯	◯
Most Common	◯	◯	◯	◯	◯	◯

Spacing of **largest** stones ..... mm

Overall Spacing of stones ..... mm

Depth of hail ..... inches or **ground just covered** ◯

Any hail **soft** or **slushy?** Yes ◯ No ◯

Estimated **percent** of soft stones ..... %

Shape of **largest** stones .....

Surface texture .....

Wind: Light ◯ Moderate ◯ Strong ◯ Severe ◯

Lightning: Yes ◯ No ◯ Don't Know ◯

Crop type: ..... Estimated **Damage** ..... %

Growth Stage: .....

Remarks:

Name .....

Address .....

Postal Code ..... Phone .....

APPENDIX 3. Daily radar/computer tape logs

C-band

Date 1981	*Times MDT	
June 24	15:24	20:36
June 26	14:37	24:00
June 27	00:00	08:11
	14:02	23:28
June 29	06:03	06:47
June 30	14:37	24:00
July 1	00:00	14:12
July 2	04:35	08:44
July 3	07:23	10:44
	20:41	24:00
July 4	00:00	00:31
	03:58	24:00
July 5	00:00	06:57
	09:20	22:29
July 6	03:16	08:20
	13:30	24:00
July 7	00:00	24:00
July 8	00:00	05:25
July 9	11:37	24:00
July 10	00:00	20:42
July 11	11:10	20:45
	22:23	23:02
July 12	01:13	12:00
	16:39	18:55
	22:20	24:00
July 13	00:00	11:21
	12:38	24:00
July 14	00:00	24:00
July 15	00:00	09:04
	19:34	24:00
July 16	00:00	08:59
	15:07	22:35
July 17	16:43	23:00
July 18	13:33	20:39
July 19	01:14	10:48
	12:09	24:00
July 20	00:00	01:14
	14:14	24:00
July 21	00:00	24:00
July 22	00:00	08:36
	13:58	15:28
July 23	13:56	21:37
July 26	14:18	24:00
July 27	00:00	07:00
	11:52	24:00
July 28	00:00	05:57
	12:51	24:00
July 29	00:00	06:40
	12:09	24:00
July 30	00:00	10:54
	13:08	21:01
July 31	05:29	08:00
	11:43	24:00
August 1	00:00	07:09
	12:50	24:00
August 2	00:00	06:55
	12:50	24:00
August 3	00:00	07:16
	11:51	22:51
August 4	00:51	10:23
	11:09	14:03
	14:36	21:51
August 5	15:39	19:02
August 7	07:21	09:16
	14:25	18:49
	19:31	20:45
August 8	08:24	10:02
	17:15	17:55
August 10	05:23	07:16
August 12	05:12	12:04
	12:42	21:19
	22:06	24:00
August 13	00:00	02:11
	03:43	06:06
	08:20	09:35
	10:47	11:07
	16:38	23:34
August 14	02:23	14:52
August 15	04:10	11:36
	13:09	24:00
August 16	00:00	01:23
	13:21	24:00
August 17	00:00	00:11
	01:56	10:13
	13:20	19:36
August 18	14:20	21:42
August 19	13:09	15:26
August 20	17:11	24:00
August 21	00:00	01:10
	07:19	13:05
	16:53	21:21
August 23	08:56	12:22
August 24	21:52	24:00
August 25	00:00	00:29
August 29	08:59	19:45
September 3	16:50	21:28

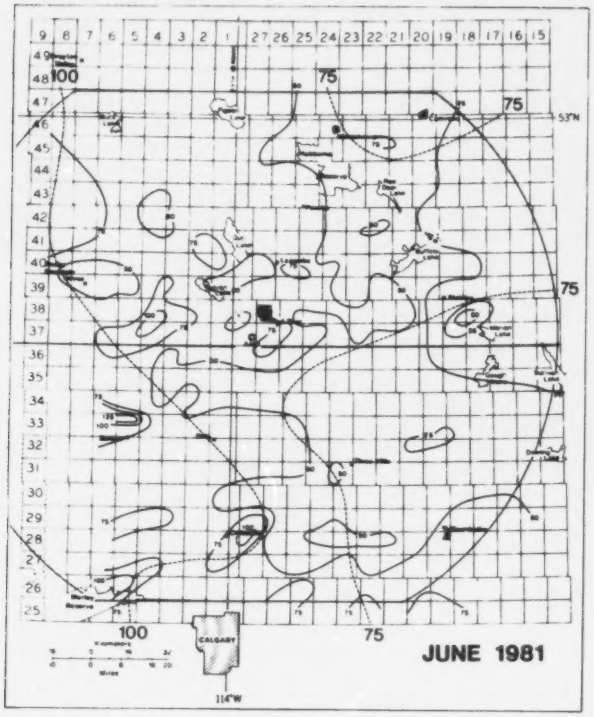
*Times are start and end of data recording. When interruptions exceeded 30 minutes, additional times are noted.

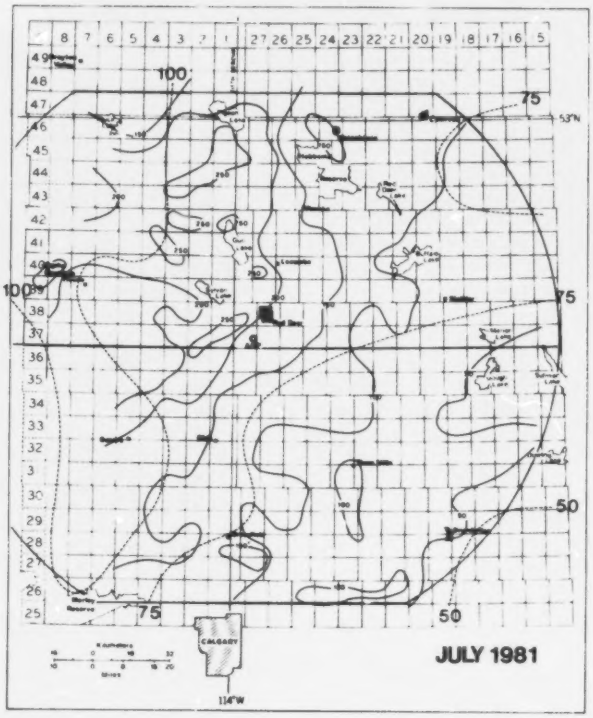
S-band

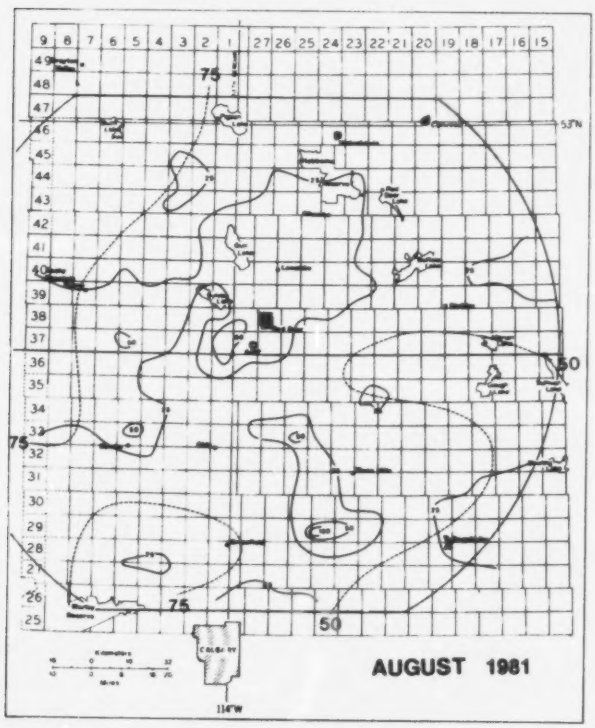
Date 1981	*Times MDT	
August 11	15:51	20:43
August 17	11:13	19:38
	21:19	21:28
August 18	18:15	18:23
	19:20	19:33
	20:50	21:43
August 19	15:27	21:11
August 20	11:51	13:13
	14:06	16:55
August 21	11:08	16:52
August 25	20:53	21:57
August 26	09:11	10:51
	16:26	21:07
August 27	15:01	20:03
August 30	07:58	17:35
September 1	13:08	18:57
	19:29	22:28
September 2	09:32	10:47
	16:04	22:20
September 4	09:29	14:38
	16:05	16:17
September 9	09:25	13:01

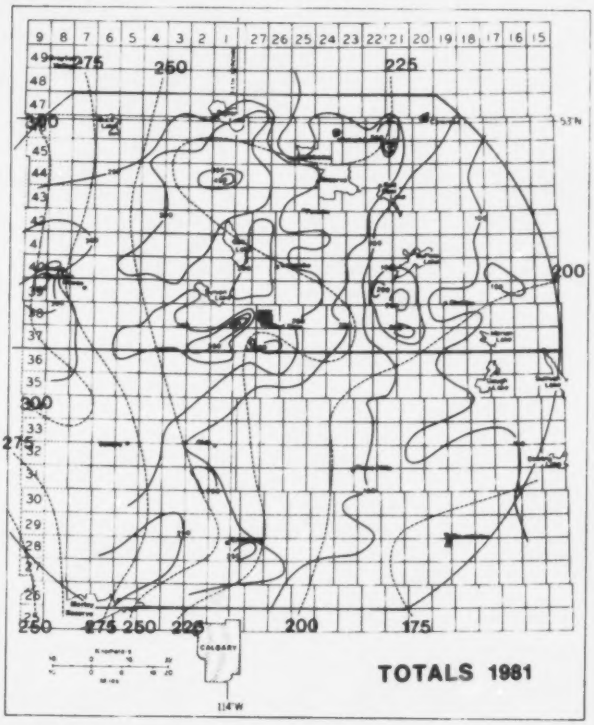
*Times are start and end of data recording. When interruptions exceeded 30 minutes, additional times are noted.

APPENDIX 4. Project Rainfall Maps









The contour lines are rainfall amounts in mm. The dashed lines are long term climatological averages.

APPENDIX 5. Daily Hailfall and Cloud Seeding Summary Map

Summary maps for all days during the operational period with;

a) 10 or more hail reports,

b) grape sized hail reported and,

c) cloud seeding activities, are presented on the following pages.

Each map shows the project boundary and:

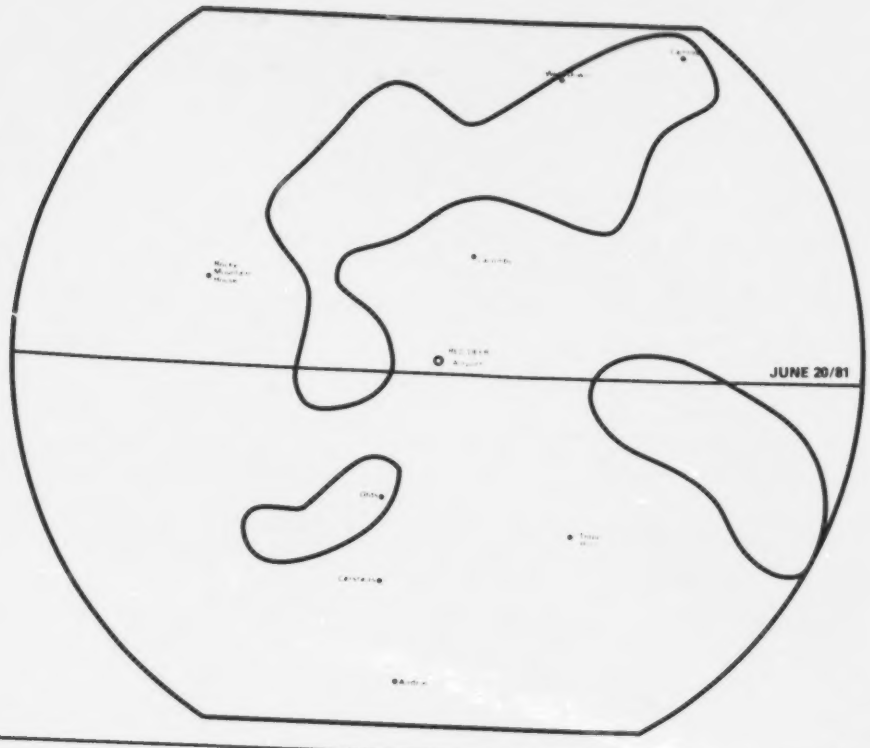
1. The hailswath area indicated by shading. Darker shading indicates areas of walnut and larger hail reported.
2. The general area (envelope) of cloud seeding activities.

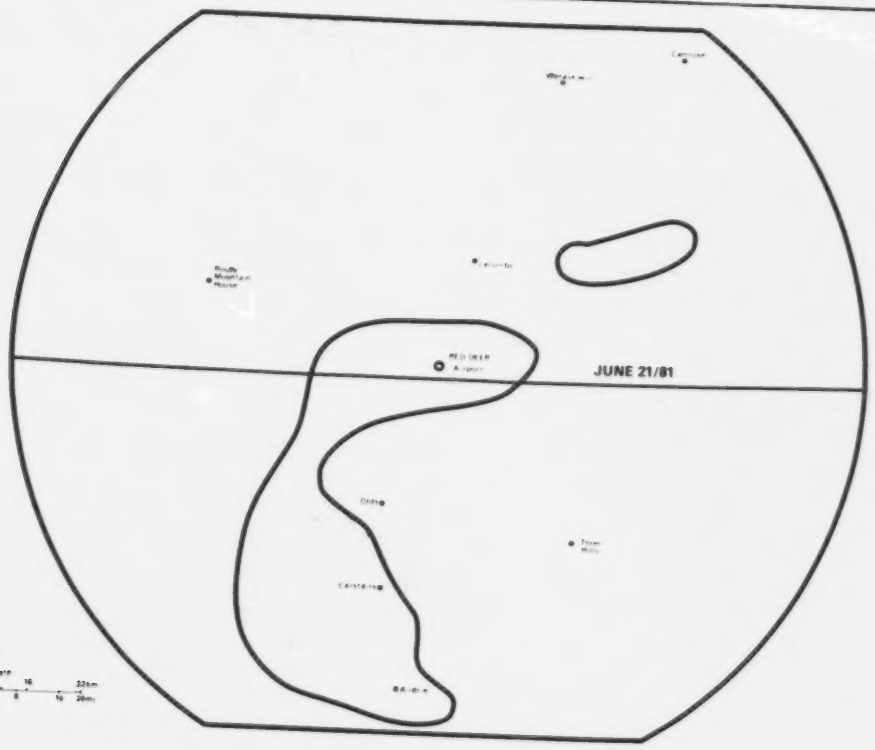
Storm dates are:

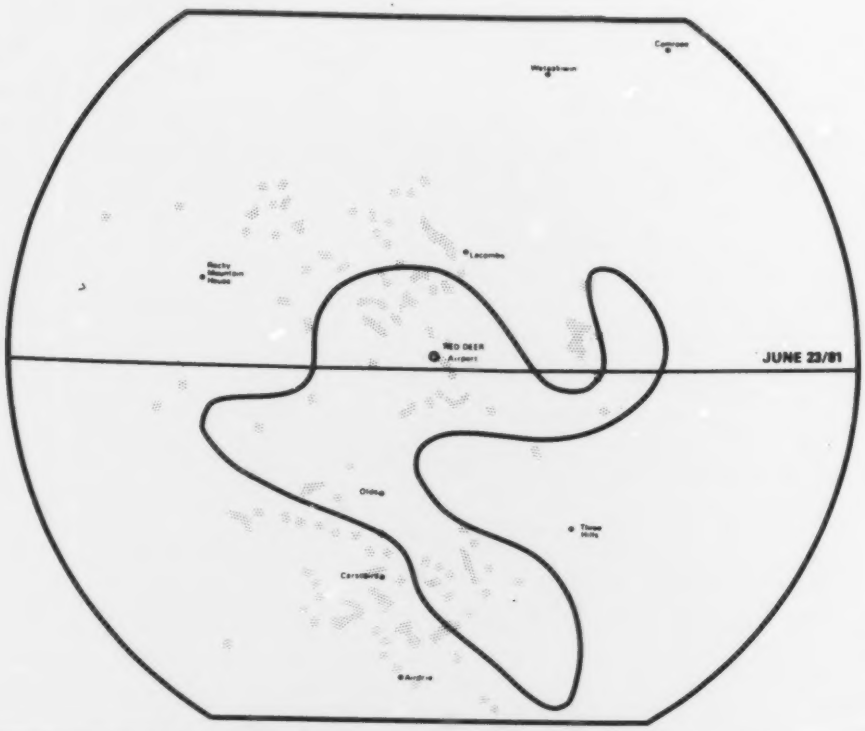
June: 20, 21, 23, 24, 26, 27, 30

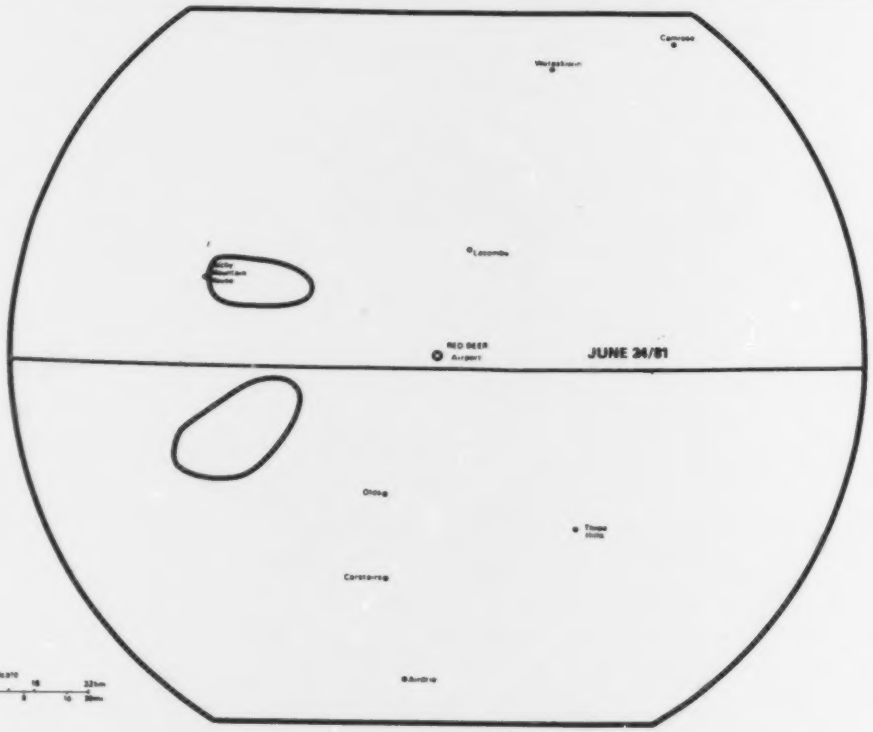
July: 4, 5, 6, 9, 11, 13, 14, 16, 17, 18, 19, 20, 23, 26, 27, 28, 29, 31

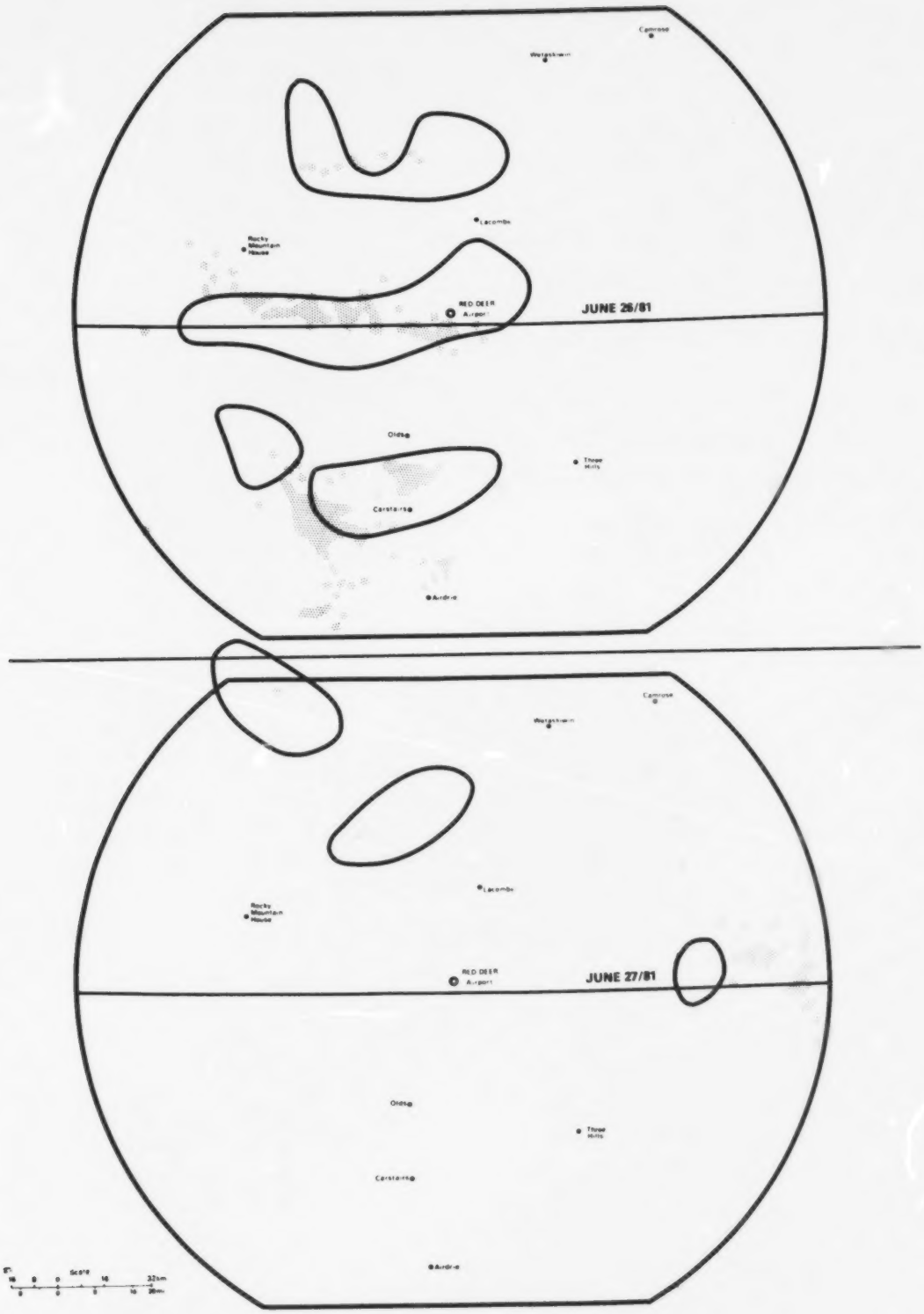
August: 1, 2, 3, 4, 5, 7, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 26

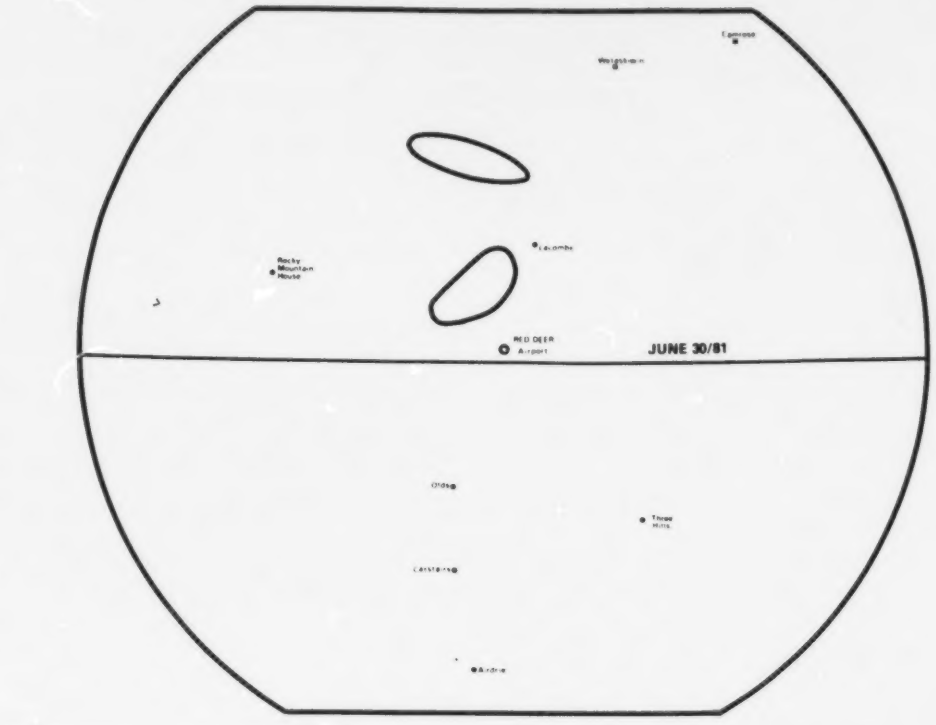

JUNE 20/81

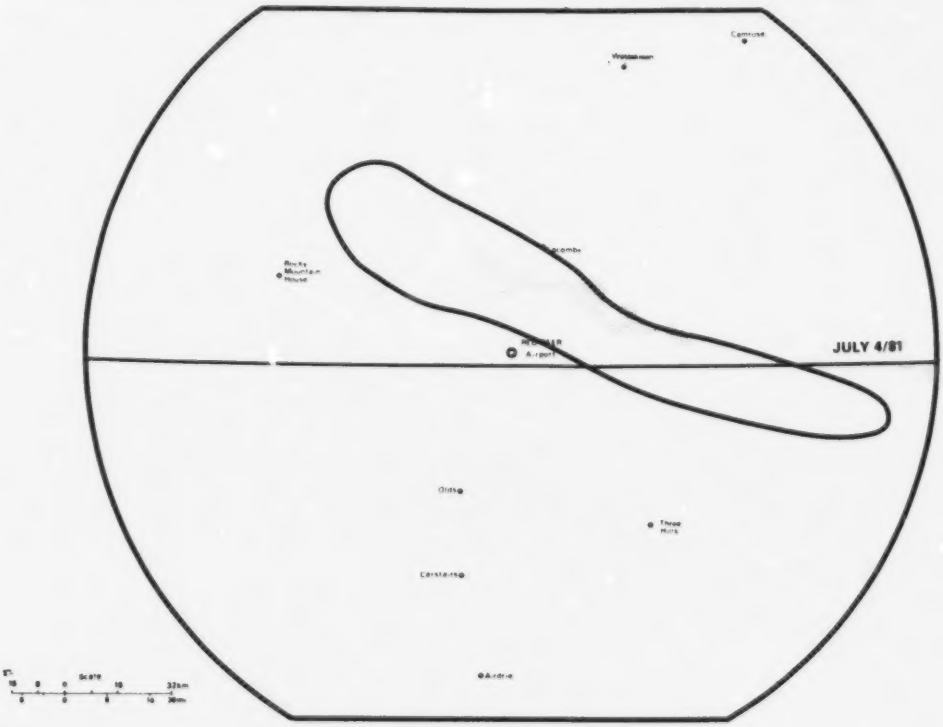

JUNE 21/81


Camrose
Wetaskiwin
Lacombe
Rocky Mountain House
RED DEER Airport
JUNE 23/81
Olds
Three Hills
Carstairs
Airdrie


Camrose
Wetaskiwin
Lacombe
Rocky Mountain House
RED DEER Airport
JUNE 24/81
Olds
Three Hills
Carstairs
Airdrie


Camrose
Lacombe
Rocky Mountain House
RED DEER Airport
JUNE 26/81
Olds
Three Hills
Carstairs
Airdrie
Camrose
Lacombe
Rocky Mountain House
RED DEER Airport
JUNE 27/81
Olds
Three Hills
Carstairs
Airdrie
Scale
32km


Camrose
Wainwright
Lacombe
Rocky Mountain House
RED DEER
Airport
JUNE 30/81
Olds
Three Hills
Carstairs
Airdrie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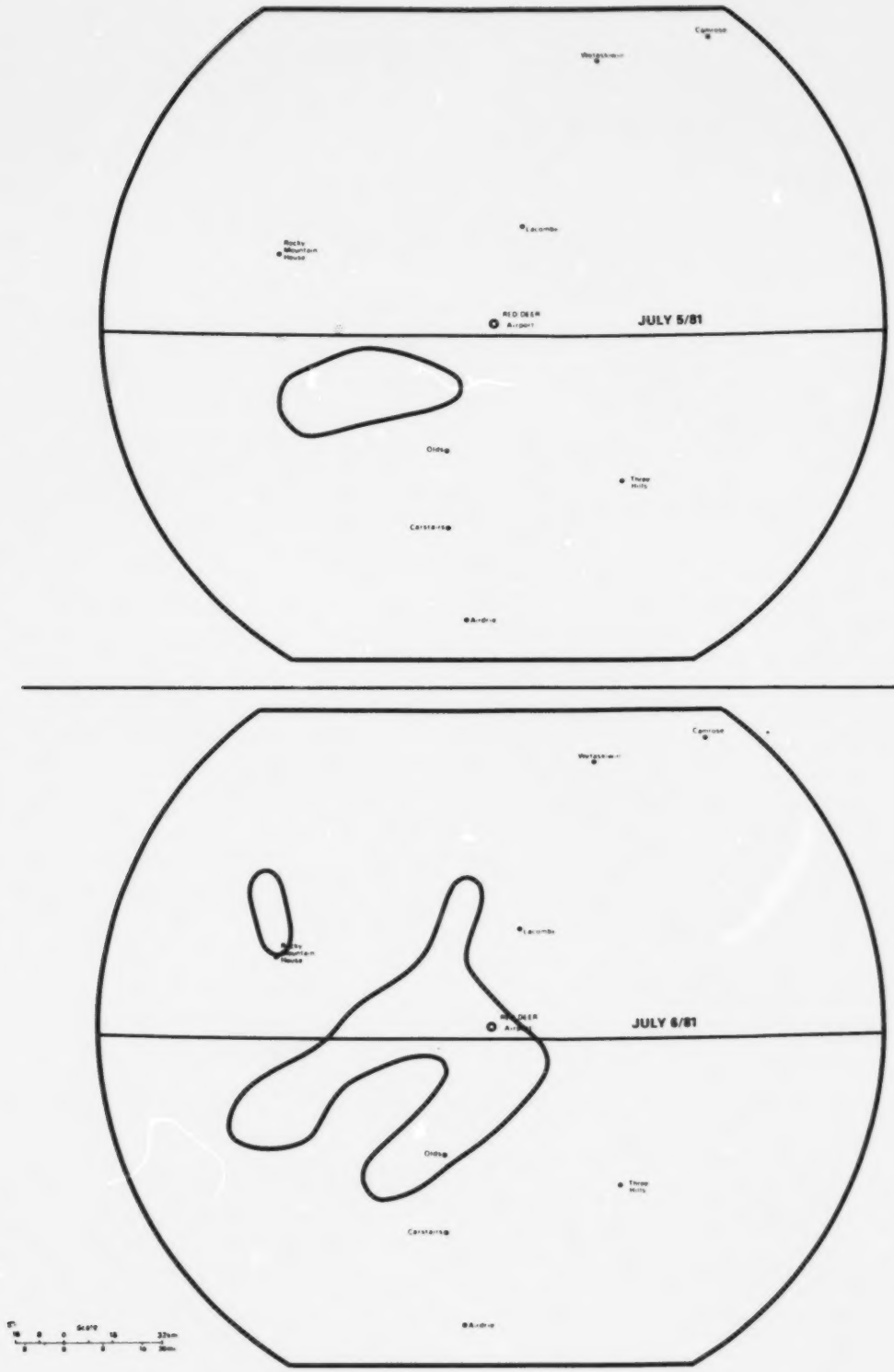
Wainwright
Lacombe
Rocky Mountain House
Airport
JULY 4/81
Olds
Three Hills
Carstairs
Airdrie
Scale
32km
30nm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Wetaskiwin
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 5/81
Olds
Three Hills
Carstairs
Airdrie
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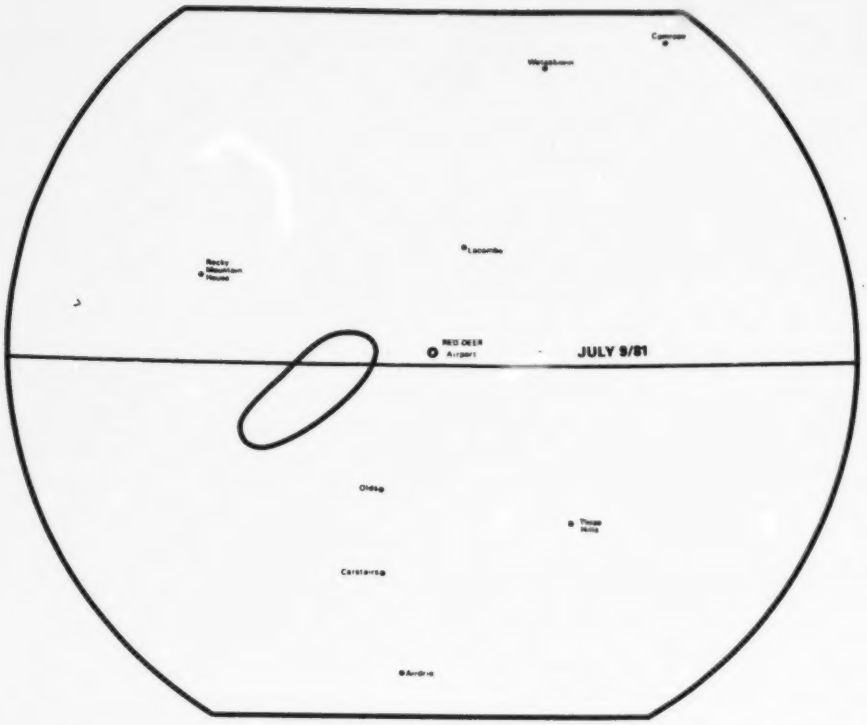
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 6/81
Olds
Three Hills
Carstairs
Airdrie
Scale
32km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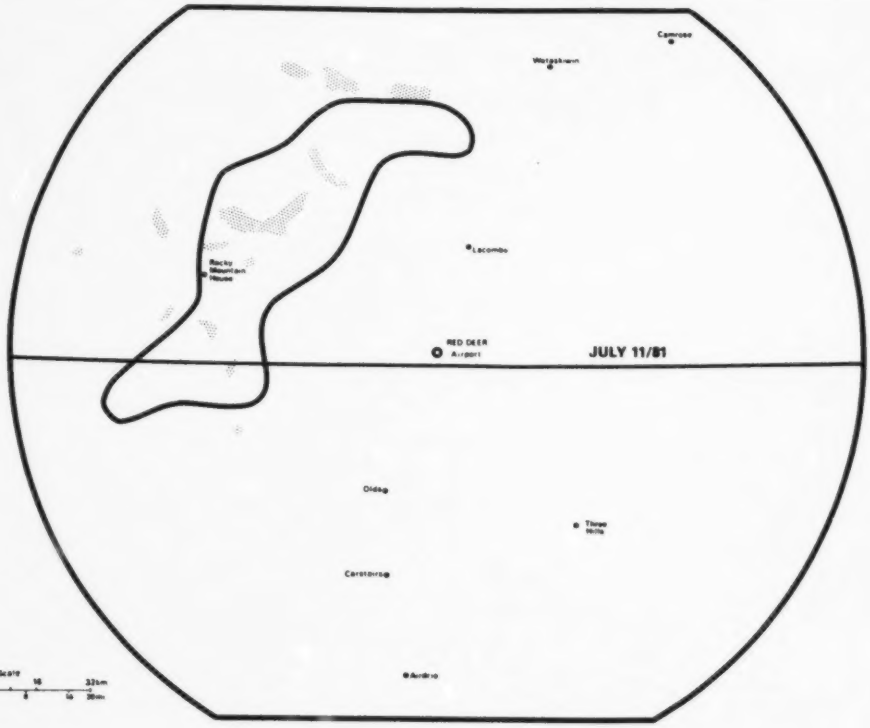
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 9/81
Olds
Three Hills
Carstairs
Airdrie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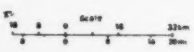
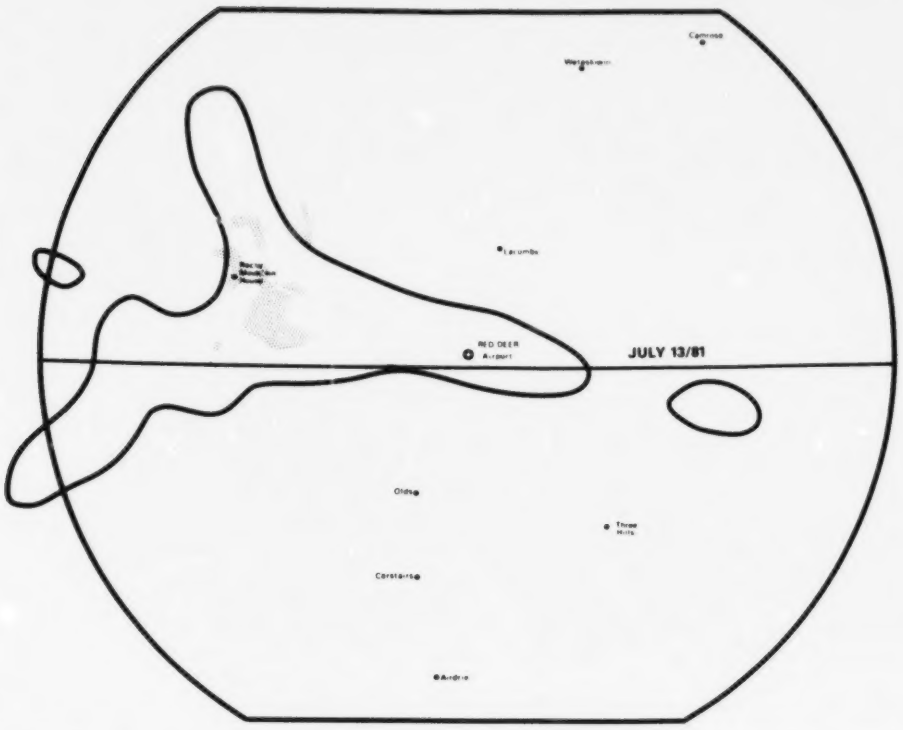
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 11/81
Olds
Three Hills
Carstairs
Airdrie


Scale
32km
20mi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Airport
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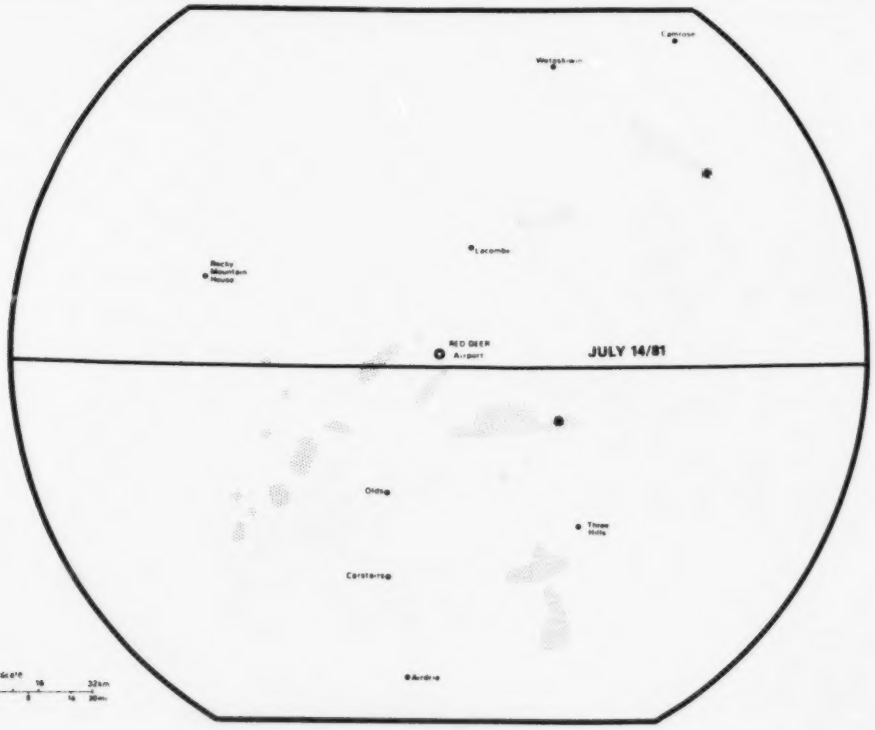
Olds
Three
Hills
Carstairs
Airdrie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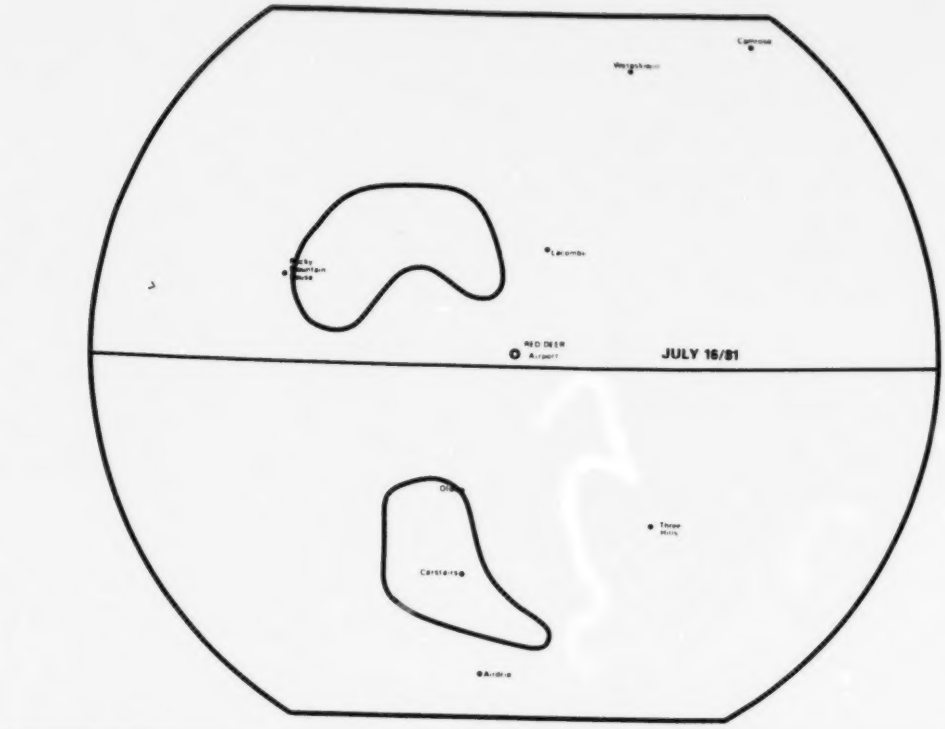
RED DEER
Airport
JULY 14/81
Olds
Three
Hills
Carstairs
Airdrie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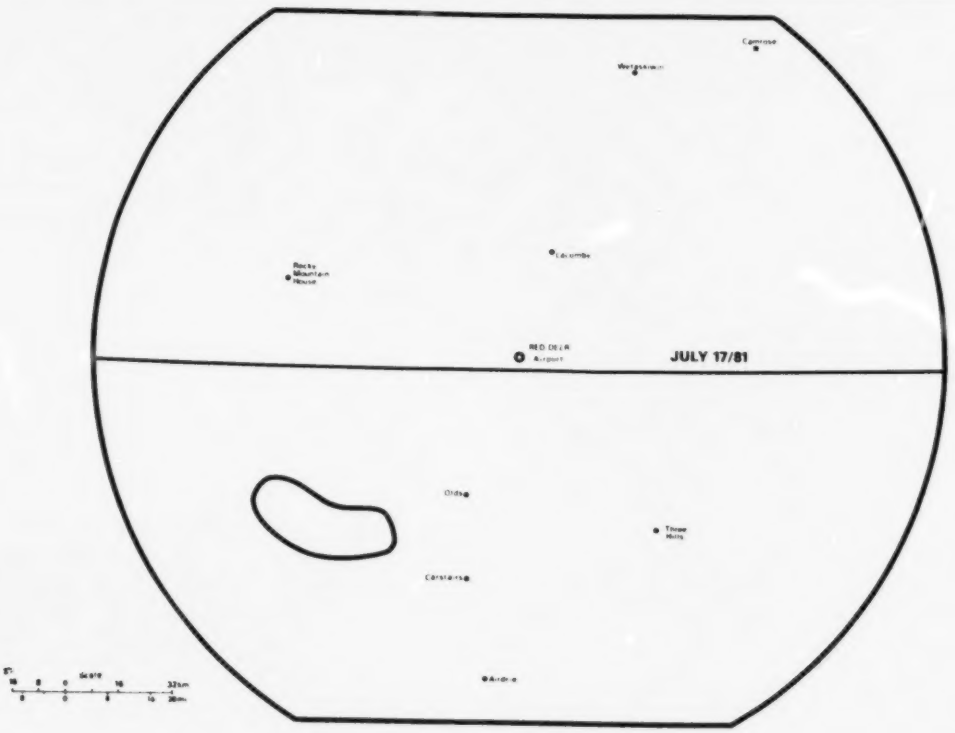
RED DEER Airport
JULY 16/81
Olds
Three Hills
Carstairs
Airdrie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Rocky Mountain House
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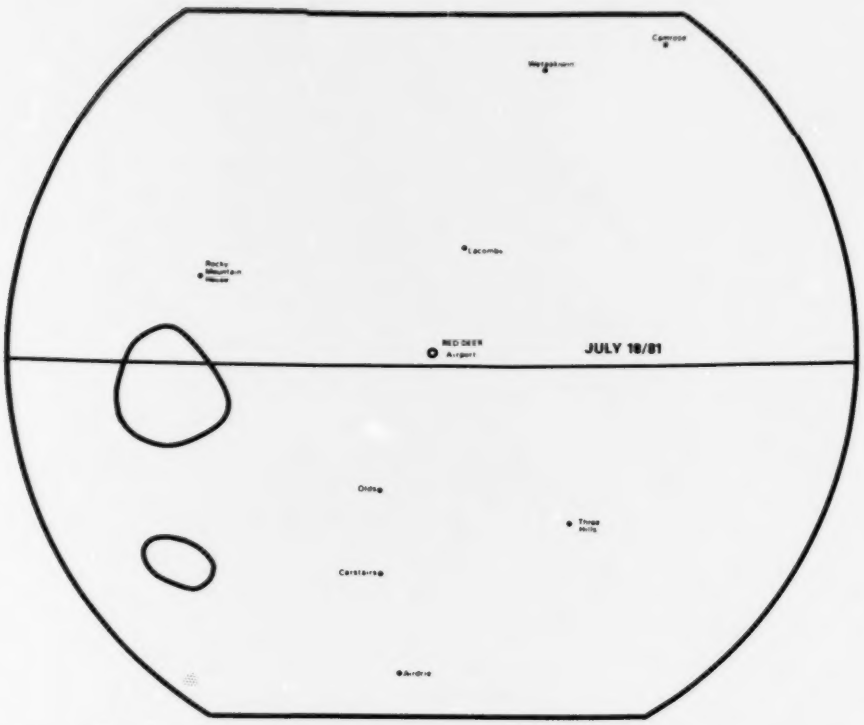
Olds
Three Hills
Carstairs
Airdrie
Scale
32km
20mi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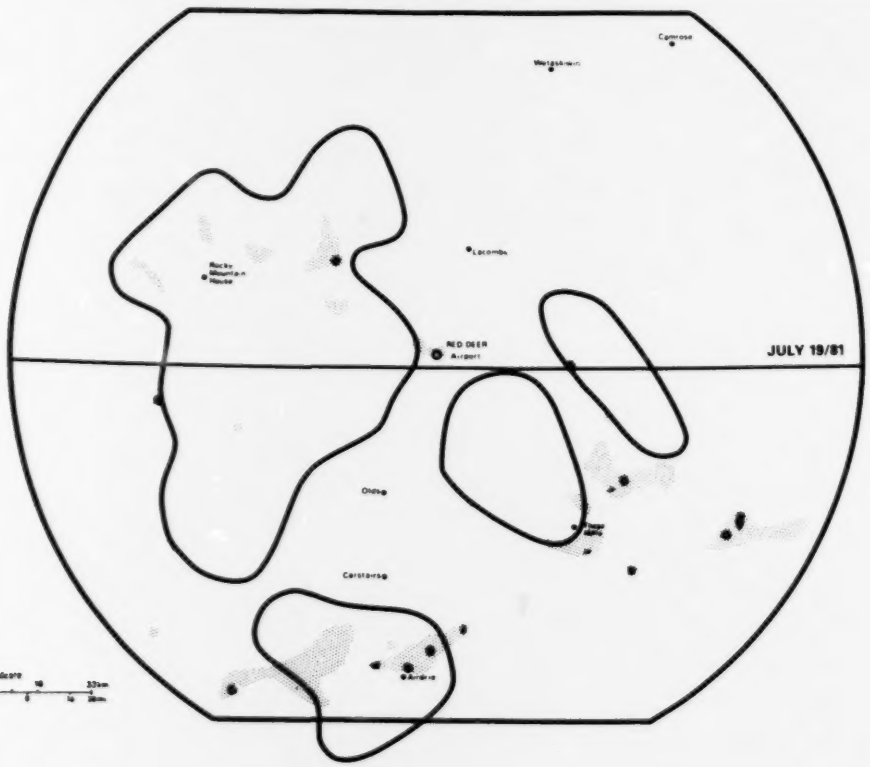
Rocky Mountain House
Lacombe
RED DEER Airport
JULY 18/81
Olds
Three Hills
Carstairs
Airdrie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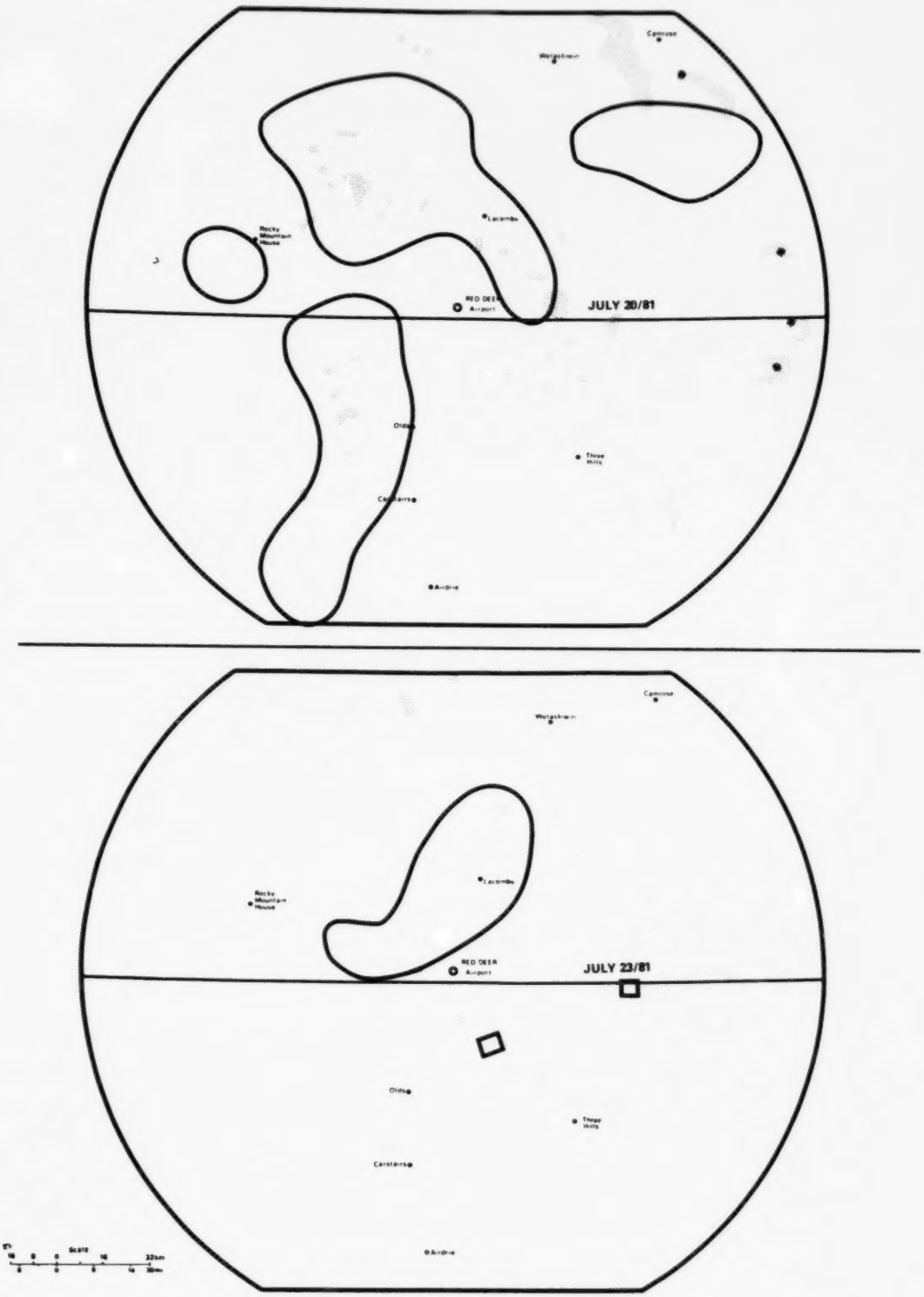
Rocky Mountain House
Lacombe
RED DEER Airport
JULY 19/81
Olds
Carstairs
Airdrie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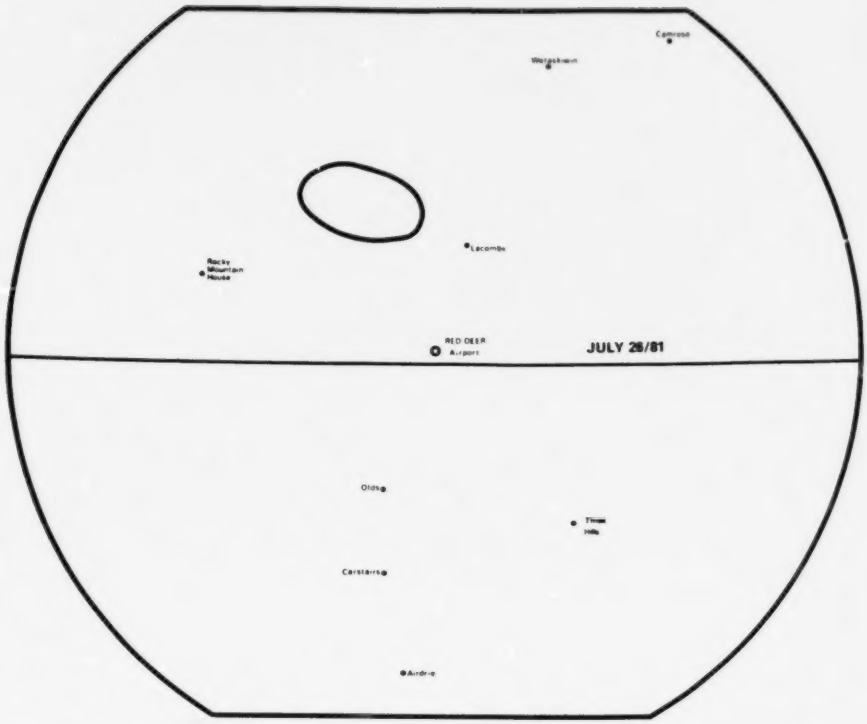
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 20/81
Three Hills
Airdrie
Camrose
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 23/81
Three Hills
Airdrie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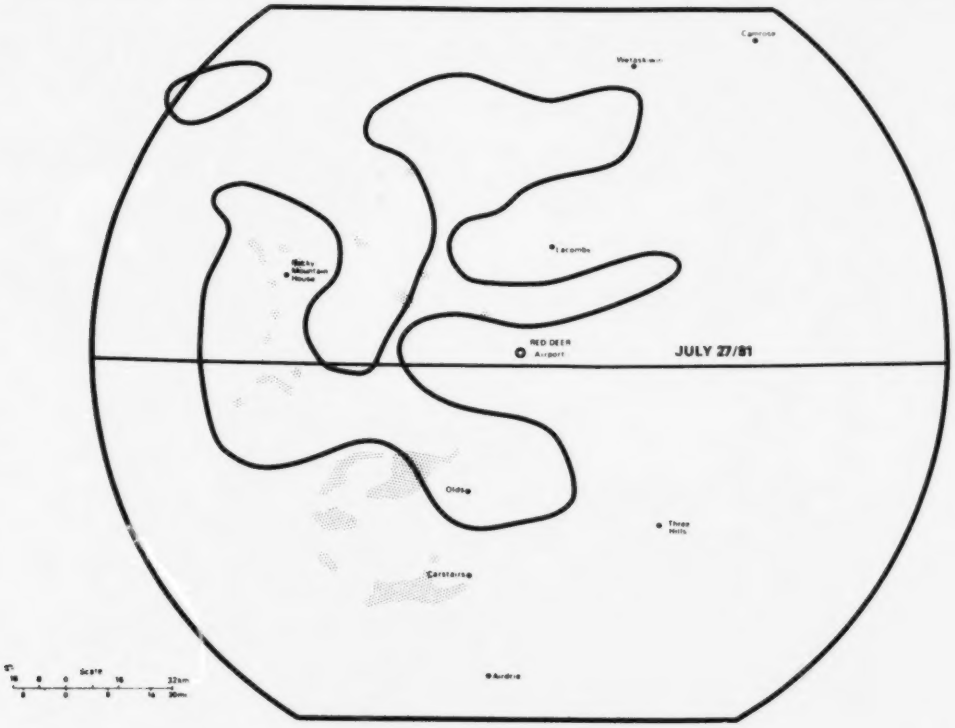
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 26/81
Olds
Three Hills
Carstairs
Airdrie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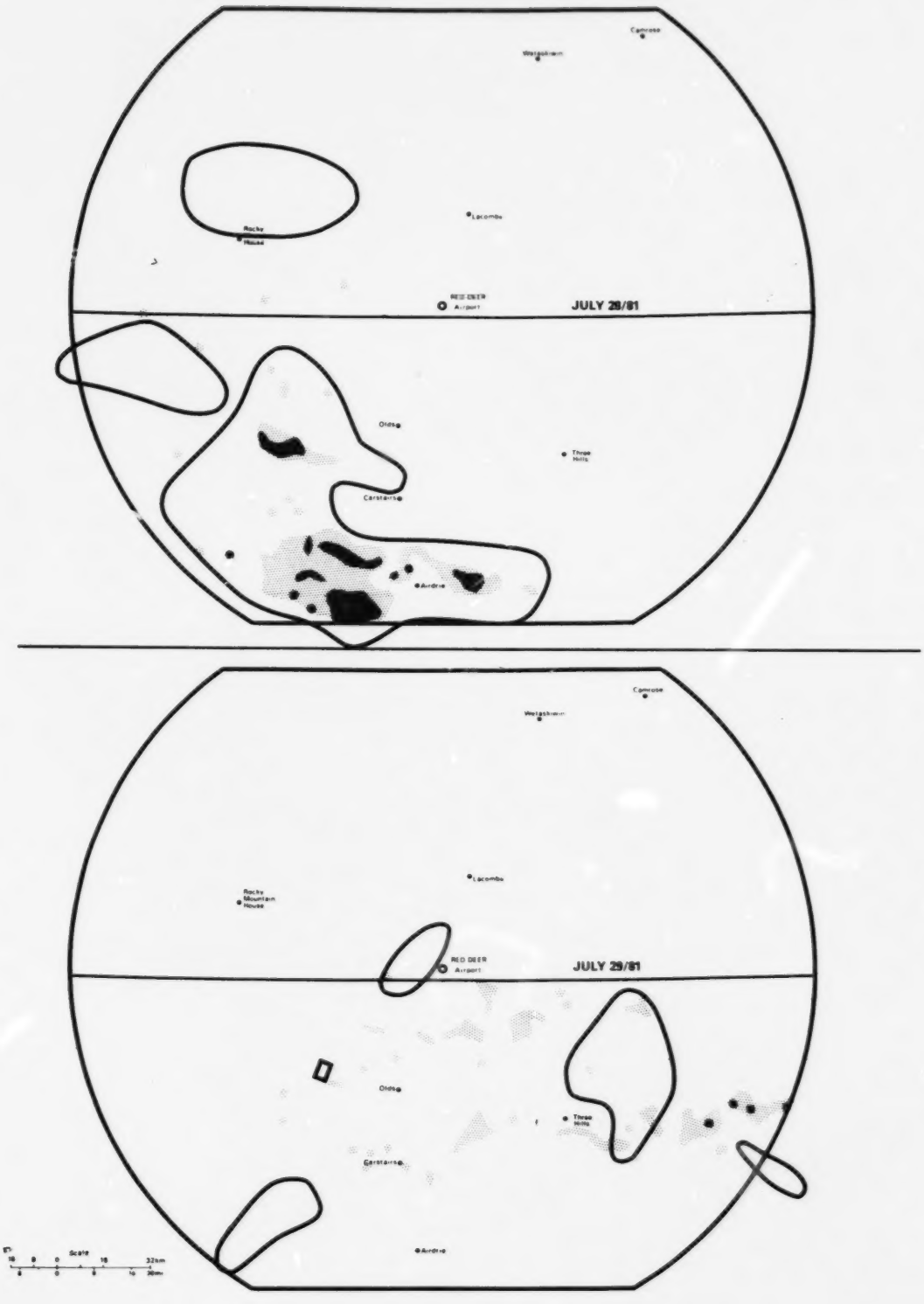
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 27/81
Olds
Three Hills
Carstairs
Airdrie

Scale
32km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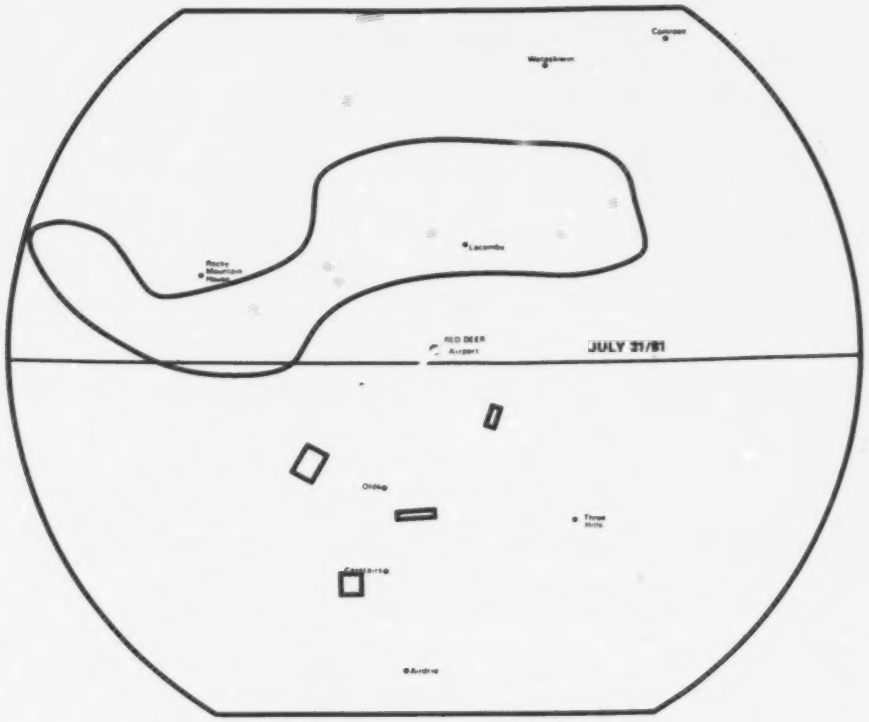
Wetaskiwin
Lacombe
Rocky
Mouse
RED DEER
Airport
JULY 29/81
Olds
Three
Hills
Carstairs
Airdrie
Canrose
Wetaskiwin
Lacombe
Rocky
Mountain
House
RED DEER
Airport
JULY 29/81
Olds
Three
Hills
Carstairs
Airdrie
Scale
16 8 0 16 32km
8 0 8 16 24m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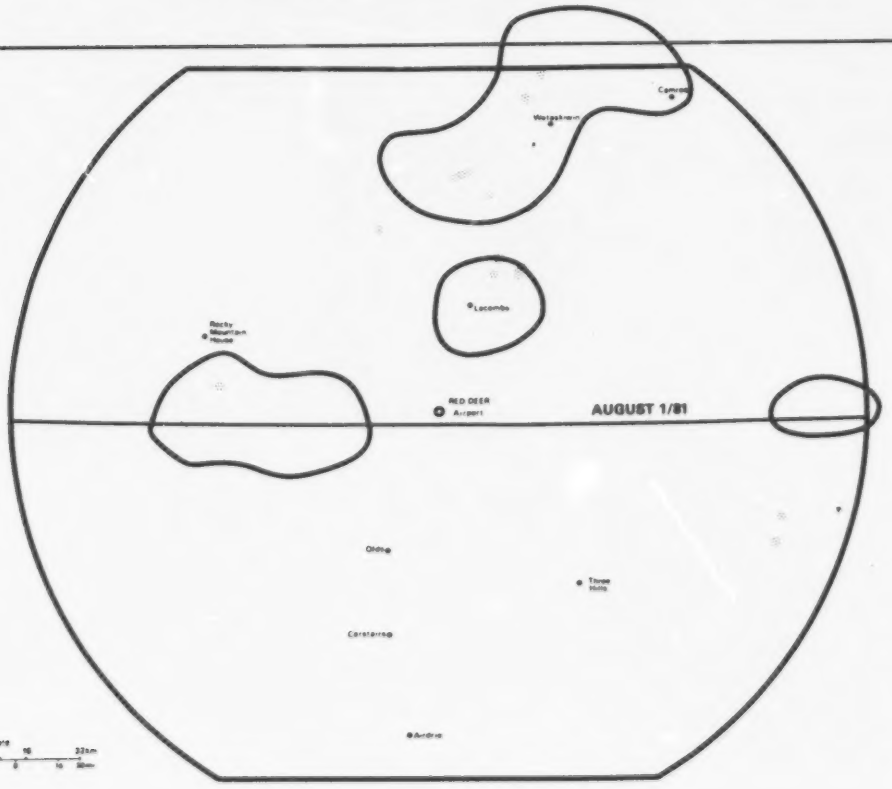
Waiparous
Lacombe
Rocky Mountain House
RED DEER Airport
JULY 31/81
Olds
Three Hills
Carstairs
Airdrie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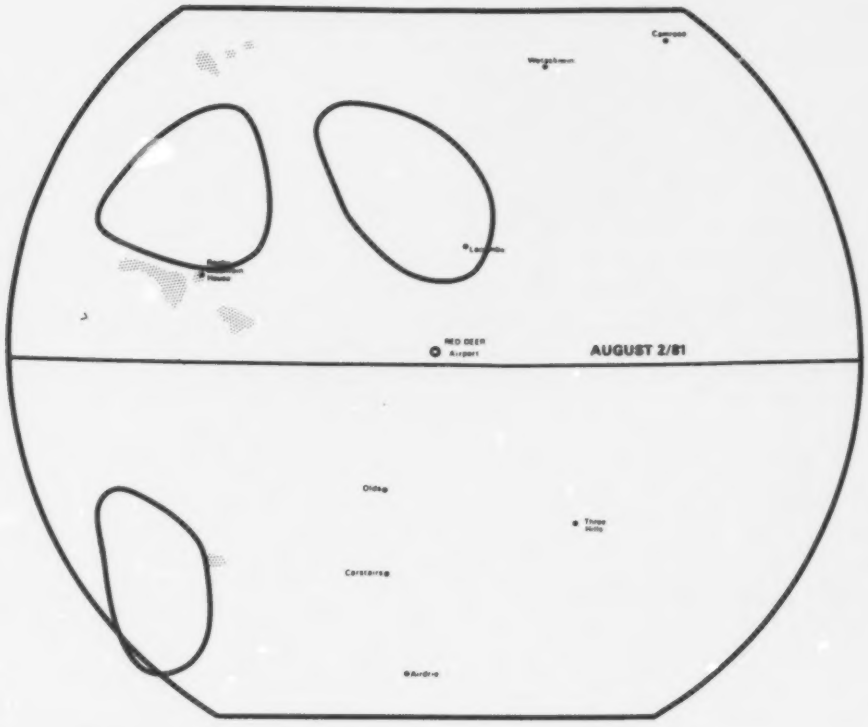
Waiparous
Lacombe
Rocky Mountain House
RED DEER Airport
AUGUST 1/81
Olds
Three Hills
Carstairs
Airdrie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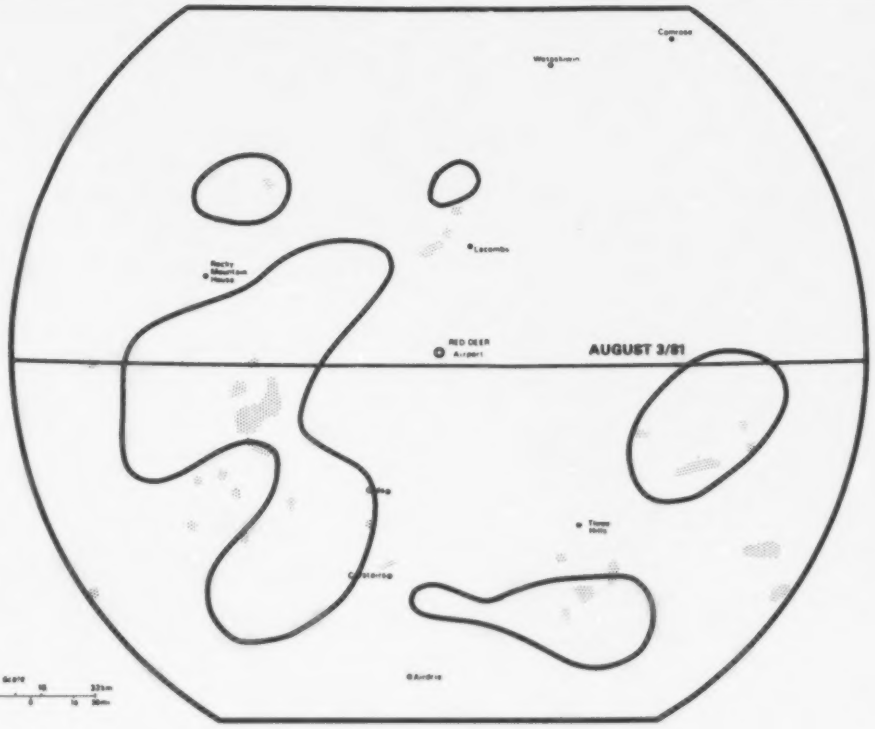
Wainwright
Lacombe
Rocky Mountain House
RED DEER Airport
AUGUST 2/81
Olds
Three Hills
Carstairs
Airdrie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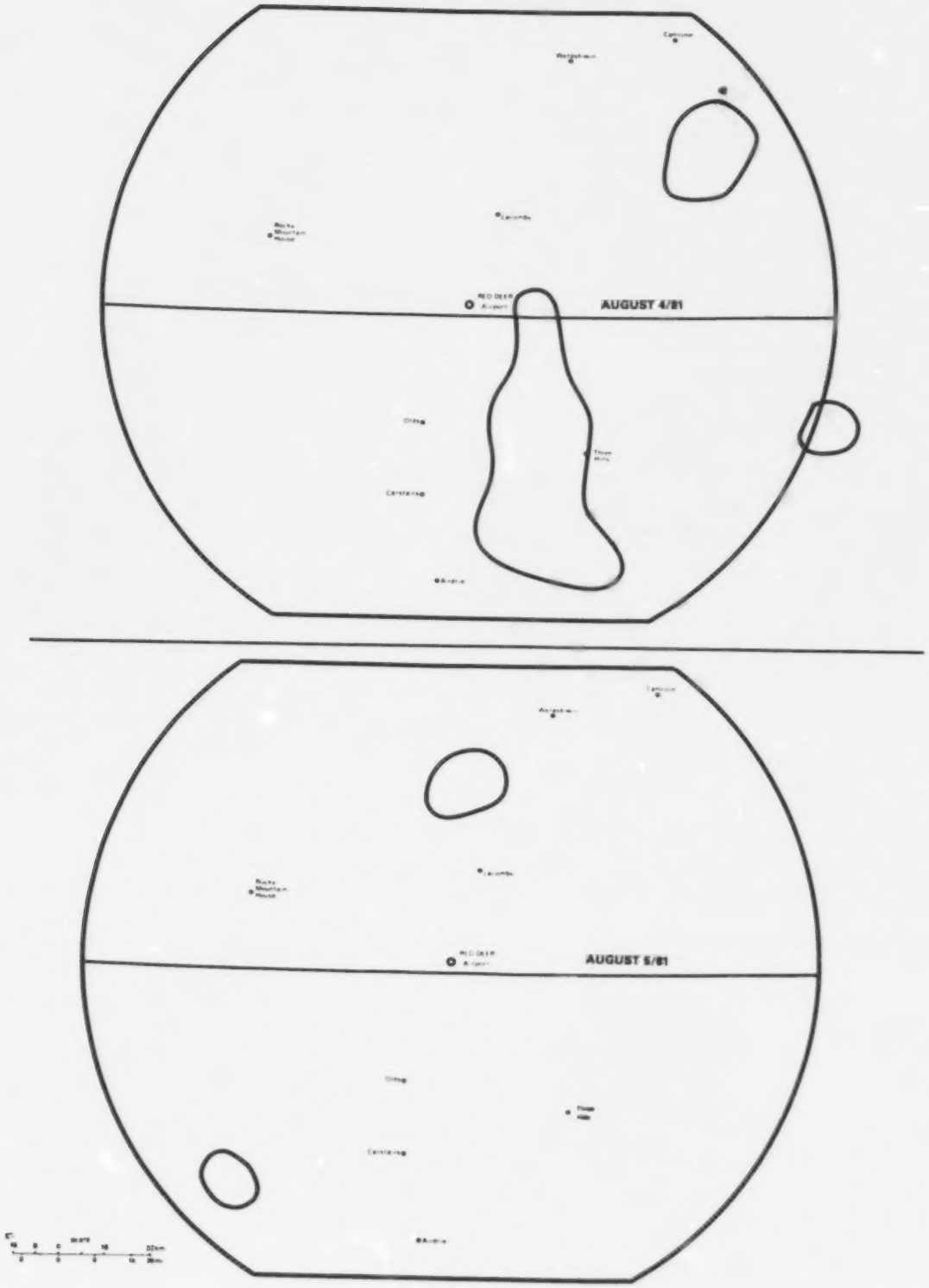
Wainwright
Lacombe
Rocky Mountain House
RED DEER Airport
AUGUST 3/81
Olds
Three Hills
Carstairs
Airdrie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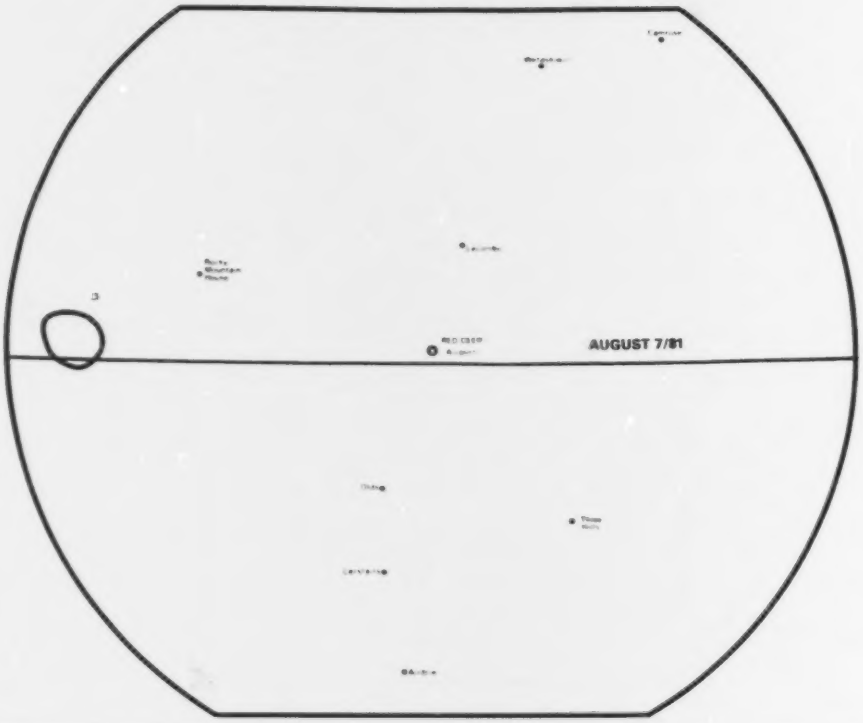
AUGUST 5/81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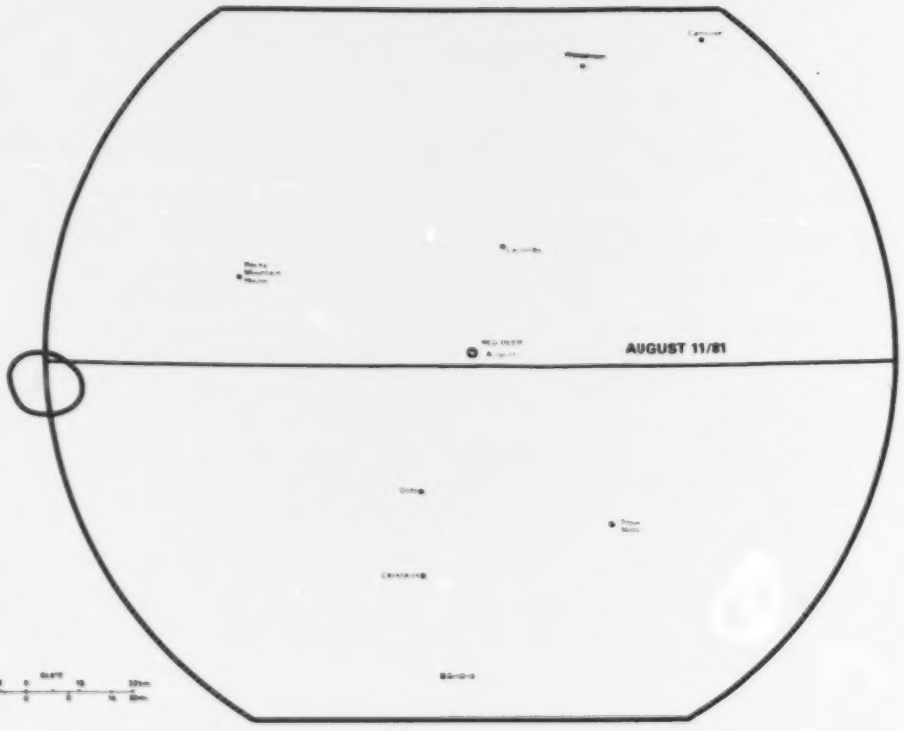
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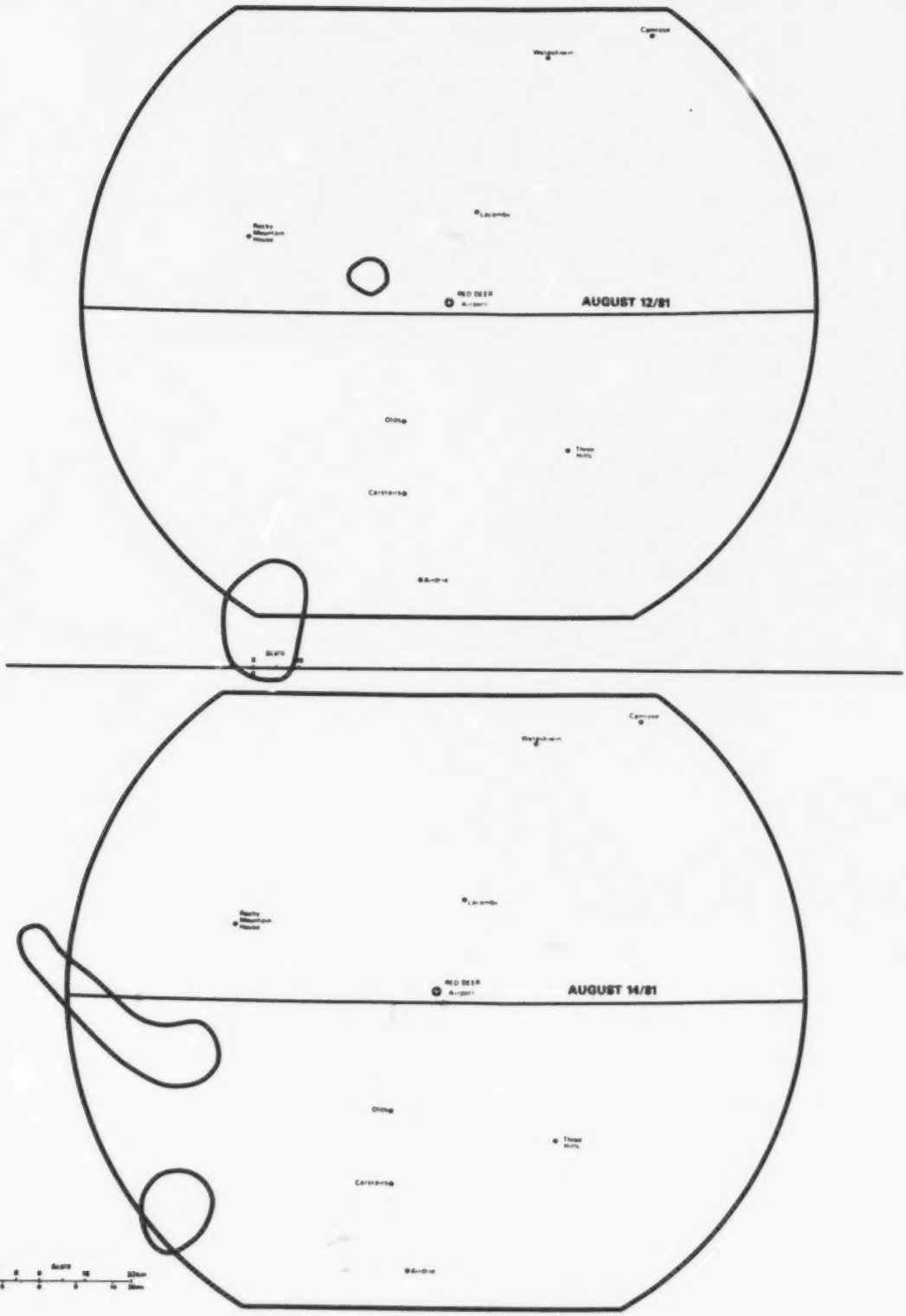
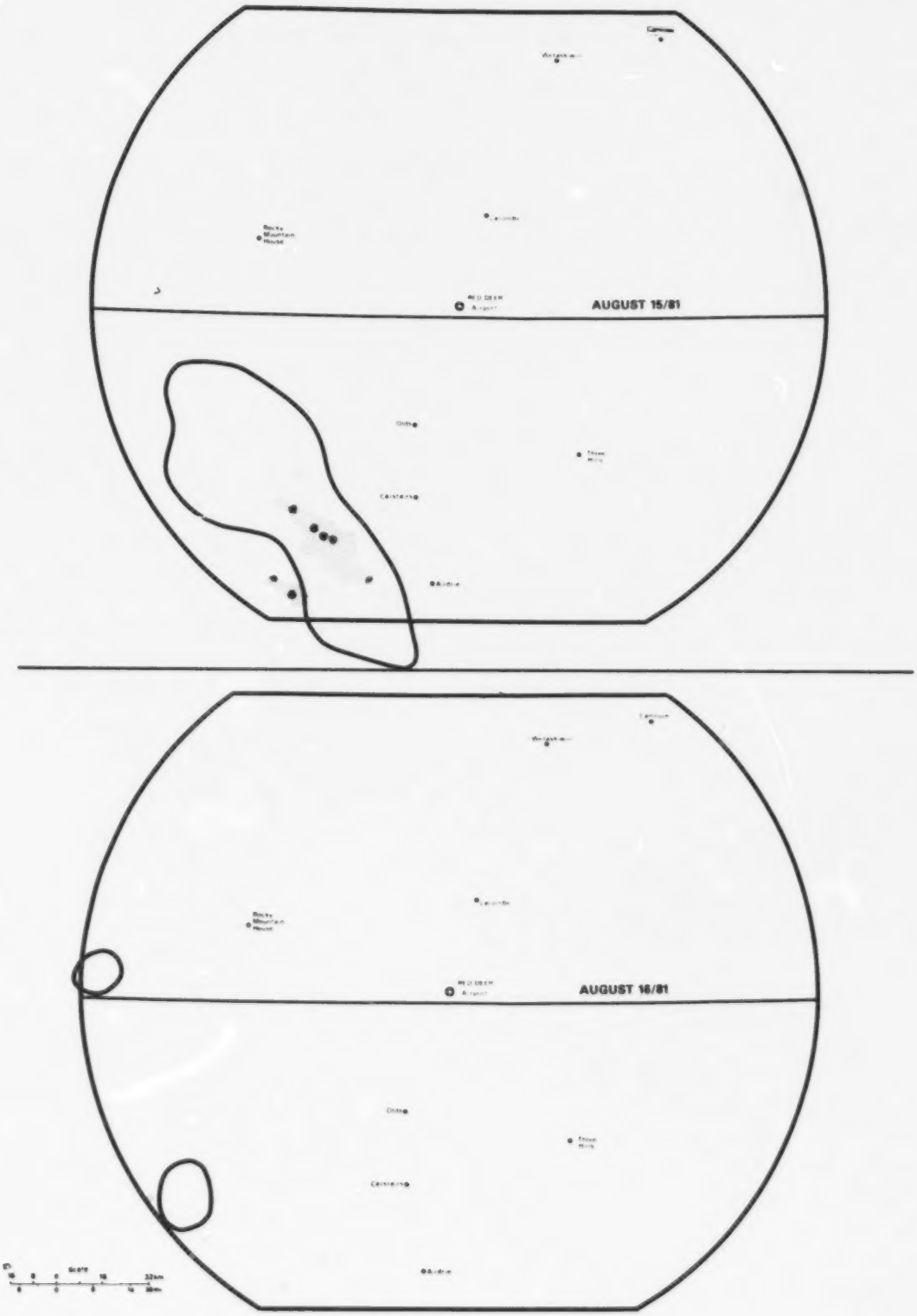

Camrose
Wetaskiwin
Lacombe
Rocky Mountain House
RED DEER Airport
AUGUST 12/81
Ponoka
Three Hills
Carstairs
Airdrie
Camrose
Wetaskiwin
Lacombe
Rocky Mountain House
RED DEER Airport
AUGUST 14/81
Ponoka
Three Hills
Carstairs
Airdrie
km
0 5 10 15 20km
0 5 10 15 20mi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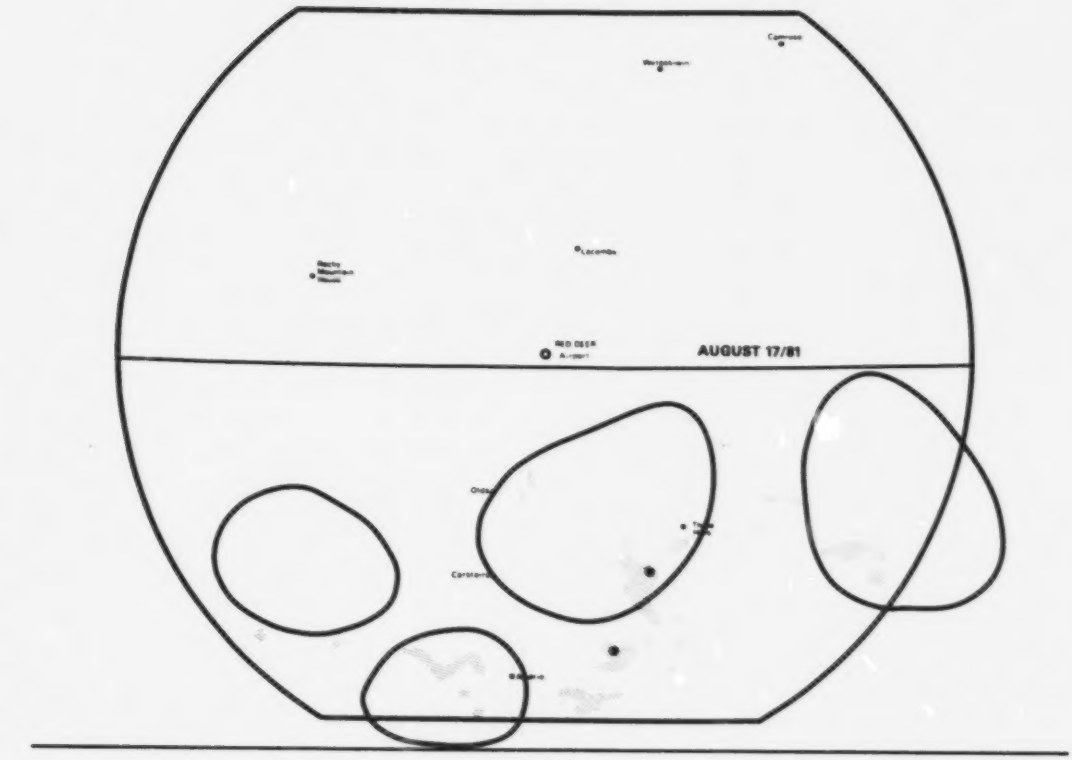
AUGUST 16/81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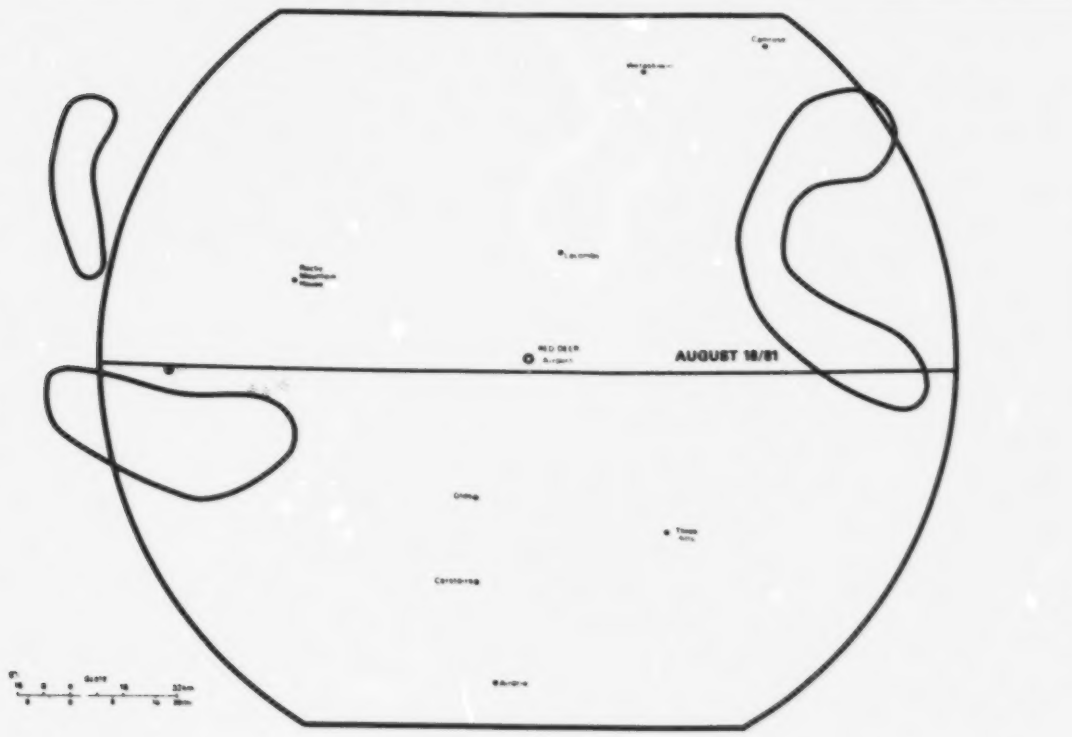
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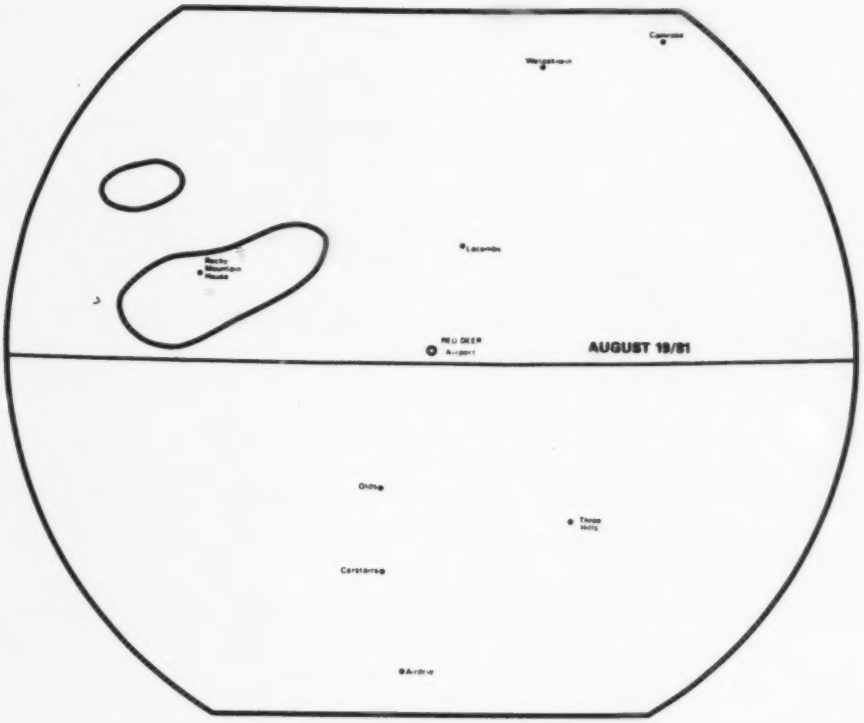
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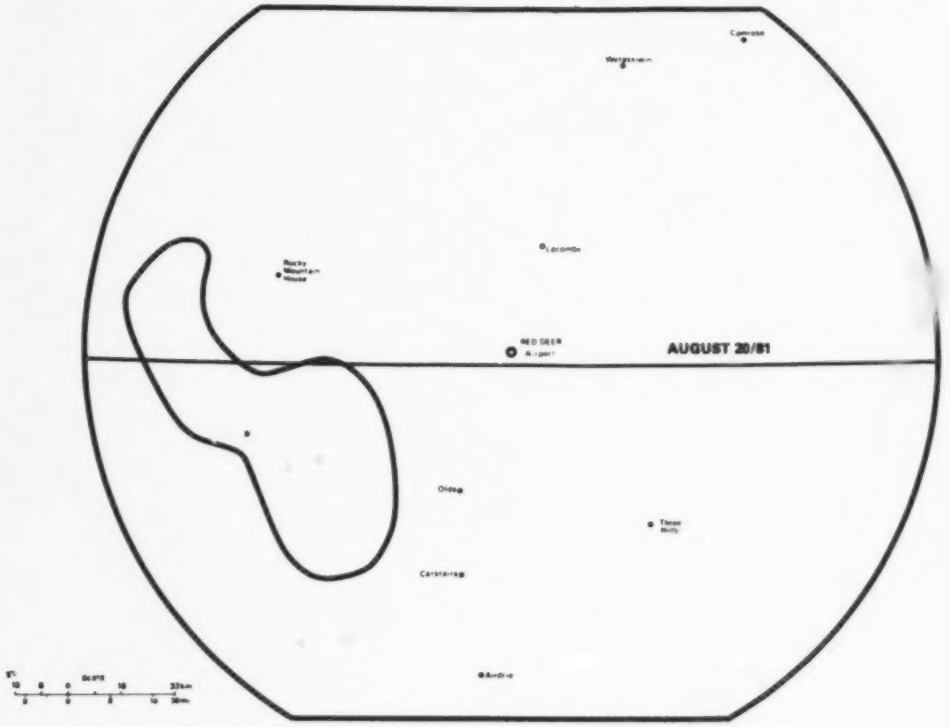
Lacombe
Rocky Mountain House
RED DEER Airport
AUGUST 19/81
Olds
Three Hills
Carstairs
Airdrie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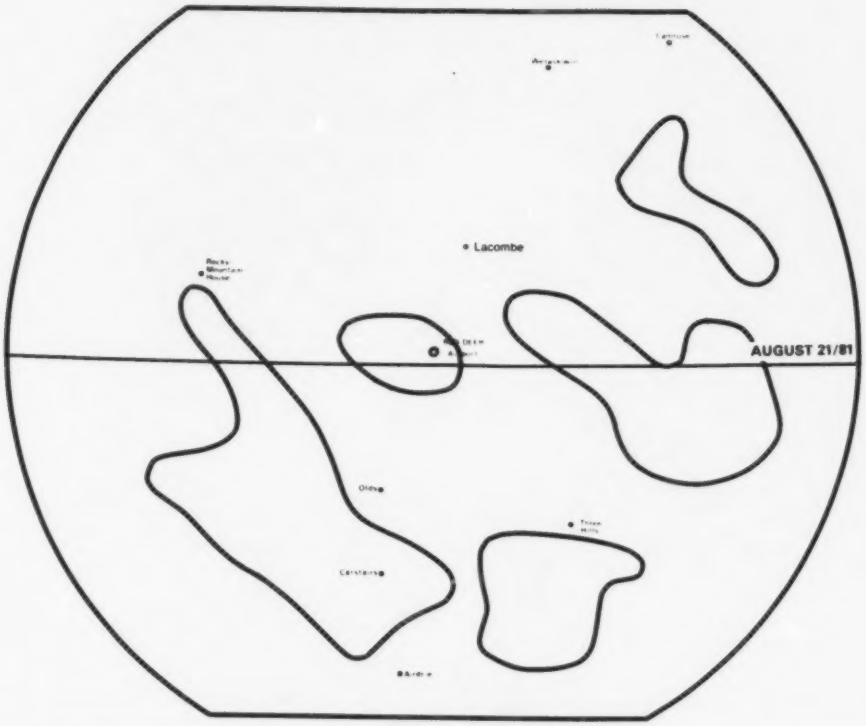
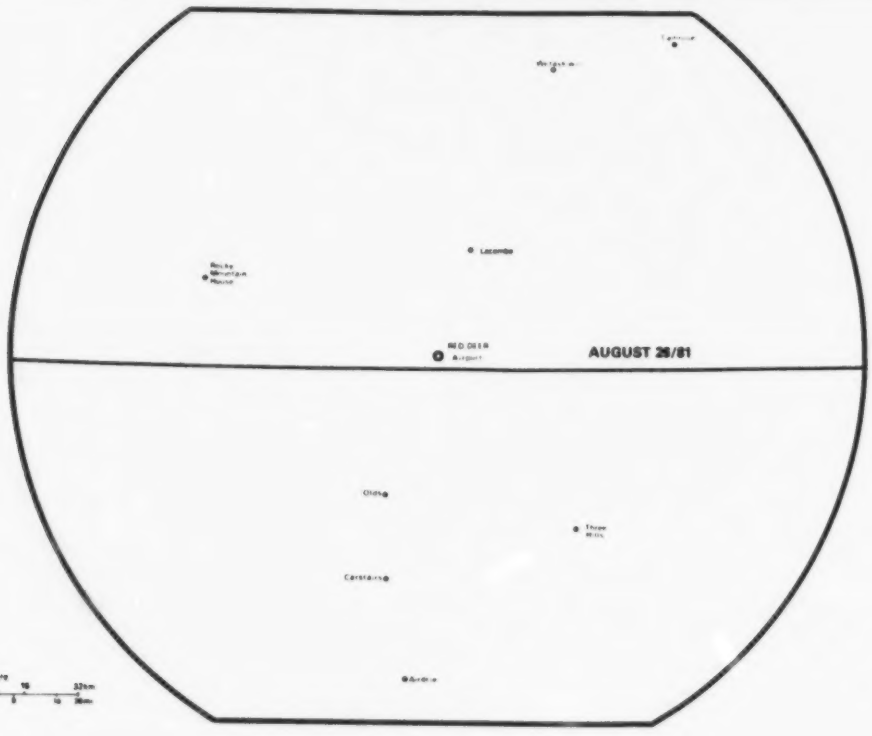
Lacombe
Rocky Mountain House
RED DEER Airport
AUGUST 20/81
Olds
Three Hills
Carstairs
Airdrie


Lacombe
AUGUST 21/81
Olds
Three Hills
Carstairs


Lacombe
RED DEER Airport
AUGUST 26/81
Olds
Three Hills
Carstairs

APPENDIX 6. Daily Meteorological and Storm Data Summaries

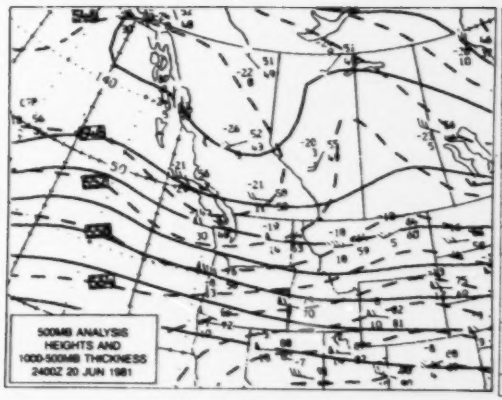
APPENDIX 6 Includes:

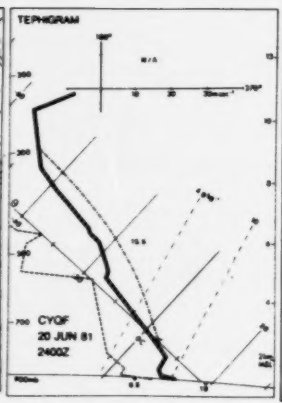
1) a 500 mb height and thickness analyses for 1800 MDT (2400Z);
2) a representative upper-air sounding (tephigram) with hodograph;
3) hail data and storm summary.

The 500 mb maps are reproduced from official AES microfilm records. Solid isopleths on 500 mb analyses are height contours at 60 m intervals, and dashed isopleths are 1000-500 thickness at 60 m intervals.

Soundings for either CYYC, CYQF or CWEG were chosen with due respect to development areas, motion and timing of the most significant storm cells. These show dry bulb (solid line) and dew point (broken line) temperatures, and the moist adiabat that best represents the storms for that day. The short horizontal bar represents cloud base. Each moist adiabat was derived from values of maximum temperature and mixing ratio (labelled at the base of the sounding) judged to be the most representative for the storm area, and not necessarily at the radiosonde station itself. Mixing ratios (to the nearest 0.5 g kg^{-1})were obtained by averaging over 50 mb or less in the mixing layer. Heights given are with reference to MSL.

The table gives a brief summary of the storm area, a breakdown of the various sizes of hail reported and a summary of cloud seeding activities for the day.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	20
Pea	40
Grape	4
Walnut	1
Golfball	
>Golfball	
Unknown	1

Median Hail Time 15:00

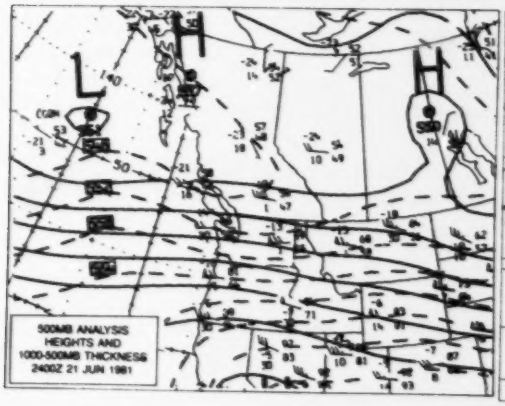
CLOUD SEEDING SUMMARY

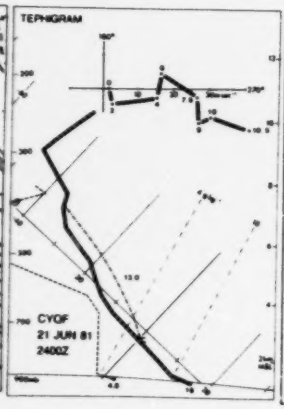
Flights	10
Hours	16.4
Top Flares	121
Base Flares	42
Acetone Gen.	7.6 Imp. Gal.

DATE

June 20, 1981

Moderate intensity storms Drayton Valley, Rimbey, Gull Lake, Ponoka, Alix and north of Rocky Mountain House. No radar data available.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	25
Pea	29
Grape	2
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 16:30

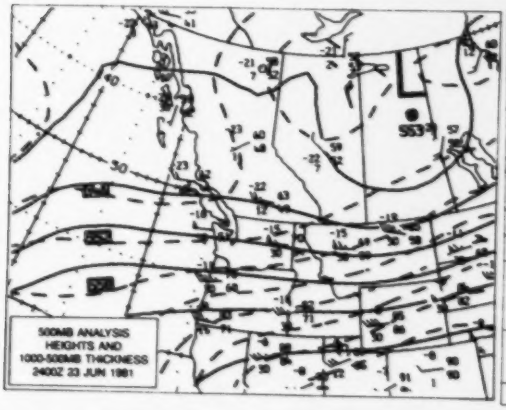
CLOUD SEEDING SUMMARY

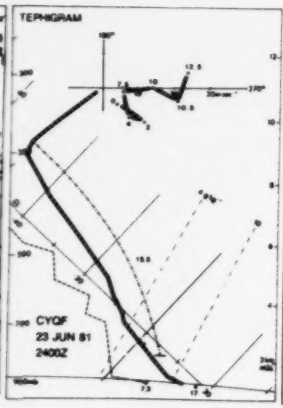
Flights	10
Hours	15.2
Top Flares	113
Base Flares	24
Acetone Gen.	5.6 Imp. Gal.

DATE

June 21, 1981

Numerous areas of moderate storm activity; Rocky Mountain House to Wetaskiwin, Pigeon Lake, east of Daysland, 20 miles south of Penhold, Buffalo Lake, and Olds to Three Hills. General tops 26K maximum 35K Pigeon Lake.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	54
Pea	120
Grape	9
Walnut	
Golfball	
>Golfball	
Unknown	5

Median Hail Time 14:00

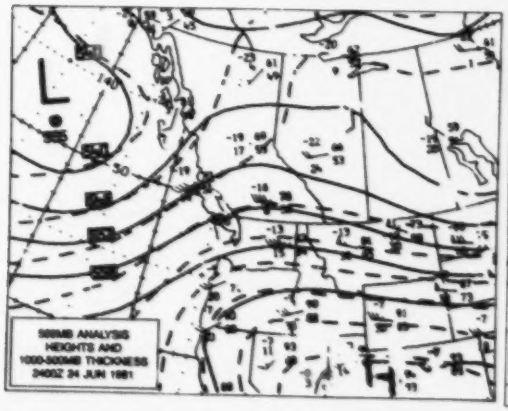
CLOUD SEEDING SUMMARY

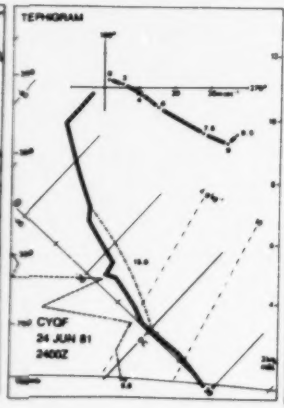
Flights	13
Hours	22.4
Top Flares	180
Base Flares	45
Acetone Gen.	6.5 Imp. Gal.

DATE

June 23, 1981

Mid afternoon storms Pigeon Lake, Rimbey, Rocky Mountain House, Sundre and Carstairs. Storms tracked southeast with maximum top 38K.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	1
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time NR

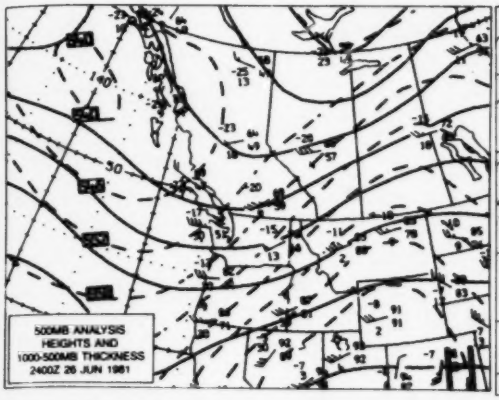
CLOUD SEEDING SUMMARY

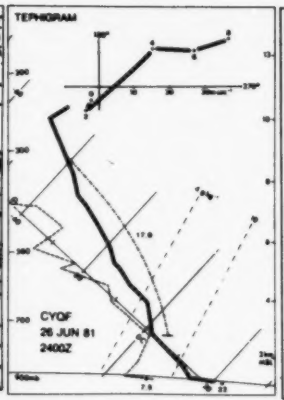
Flights	4
Hours	5.6
Top Flares	84
Base Flares	
Acetone Gen.	2.5 Imp. Gal.

DATE

June 24, 1981

Weak cells Rocky Mountain House and Caroline.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	34
Pea	67
Grape	58
Walnut	
Golfball	
>Golfball	
Unknown	5

Median Hail Time 18:00

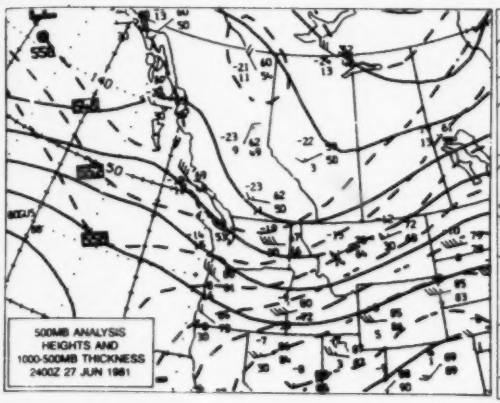
CLOUD SEEDING SUMMARY

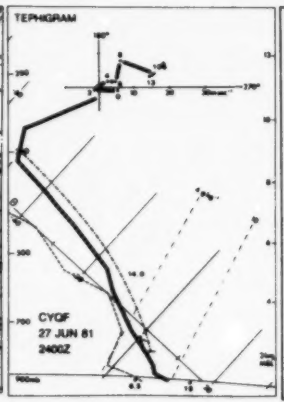
Flights	8
Hours	17.2
Top Flares	286
Base Flares	29
Acetone Gen.	3.6 Imp. Gal.

DATE

June 26, 1981

Moderate storms Rimbey area, Crimson Lake, Cremona, Didsbury, Crossfield and Cochrane areas. Storms tracked southeastward with numerous reports grape hail.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	20
Pea	36
Grape	2
Walnut	
Golfball	
>Golfball	
Unknown	4

Median Hail Time 18:30

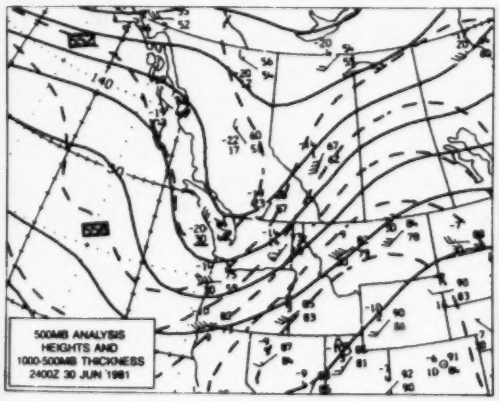
CLOUD SEEDING SUMMARY

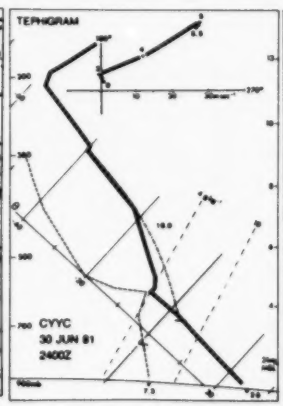
Flights	4
Hours	10.3
Top Flares	30
Base Flares	30
Acetone Gen.	1.7 Imp. Gal.

DATE

June 27, 1981

Rainshowers early afternoon Sundre northeast to Sylvan Lake. Late afternoon numerous isolated small cells throughout the north project area. Most active areas Rimbey, Wetaskiwin, New Norway, Halkirk and Stettler. Maximum tops 32K Stettler area.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	2
Pea	
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	1

Median Hail Time 23:40

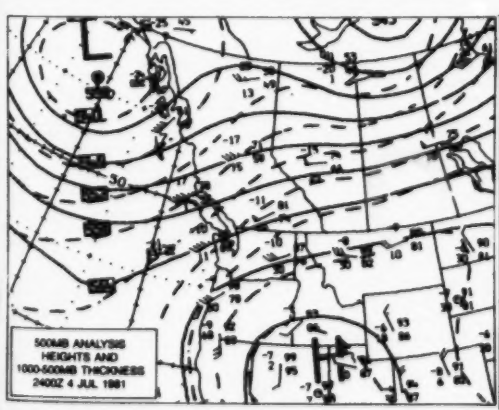
CLOUD SEEDING SUMMARY

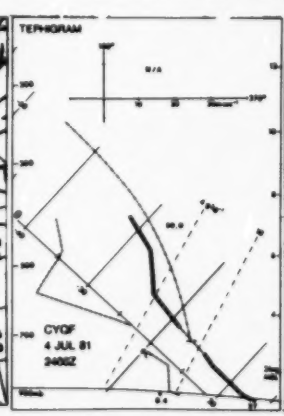
Flights	2
Hours	4.0
Top Flares	6
Base Flares	
Acetone Gen.	.7 Imp. Gal.

DATE

June 30, 1981

Weak storm began forming about 1700 in a line from Caroline northeast to Wetaskiwin tops 21K. Storms moved slowly southeast giving isolated rainshowers. Maximum tops 24K. Rainshowers persisted overnight and into morning of July 1 primarily southeast project area.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	7
Pea	14
Grape	3
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 19:00

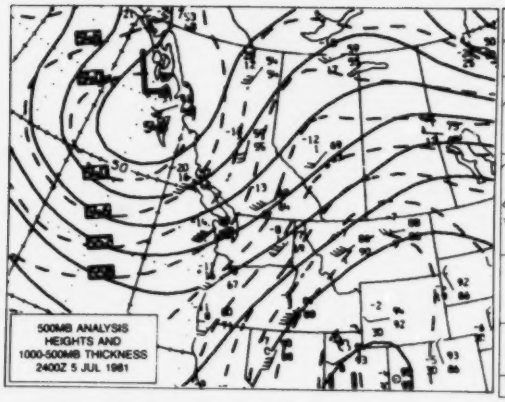
CLOUD SEEDING SUMMARY

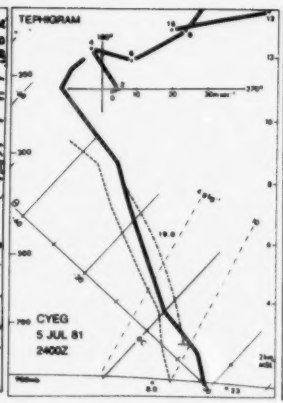
Flights	7
Hours	13.5
Top Flares	330
Base Flares	32
Acetone Gen.	Imp. Gal.

DATE

July 4, 1981

Late evening storm activity from Gull Lake to Coronation.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	1
Pea	
Grape	1
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 16:00

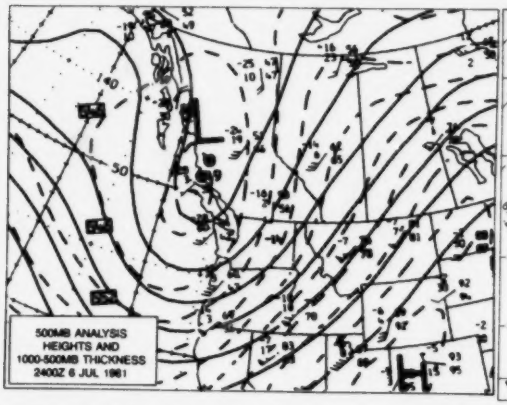
CLOUD SEEDING SUMMARY

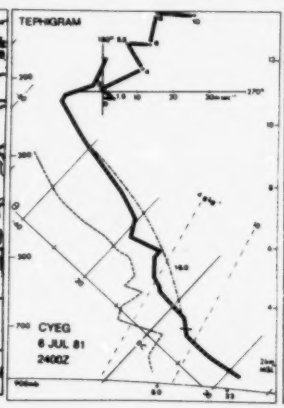
Flights	5
Hours	9.5
Top Flares	
Base Flares	10
Acetone Gen.	Imp. Gal.

DATE

July 5, 1981

Weak line of storms from Limestone Mountain northeast to Alder Flats. Line moved southeast with tops to 30K in the Caroline area. Line dissipated about 1700, 20 miles west of Penhold only weak isolated rainshowers remainder of evening.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time

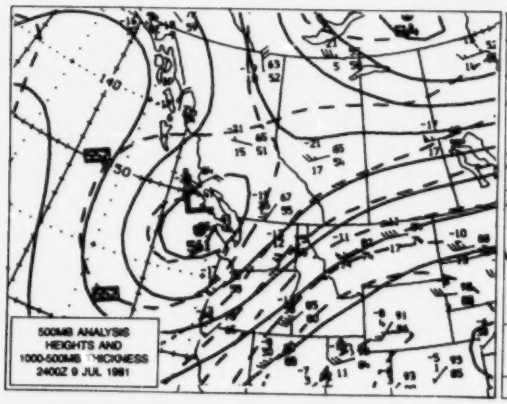
CLOUD SEEDING SUMMARY

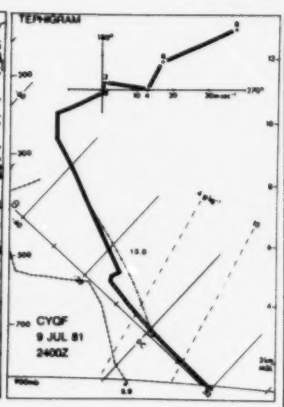
Flights	8
Hours	16.5
Top Flares	481
Base Flares	33
Acetone Gen.	6.7 Imp. Gal.

DATE

July 6, 1981

Weak storms throughout the west half of the project area most of the day. Maximum tops 25K Rimbey area. Maximum 49dBZ.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time

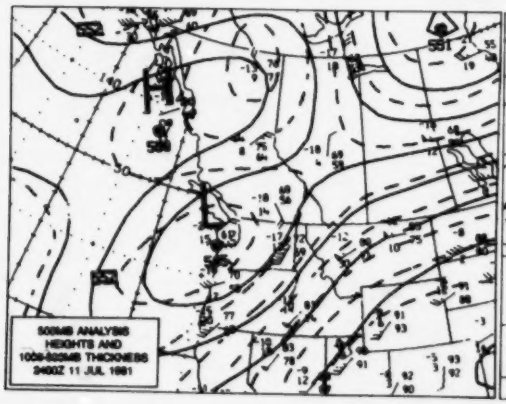
CLOUD SEEDING SUMMARY

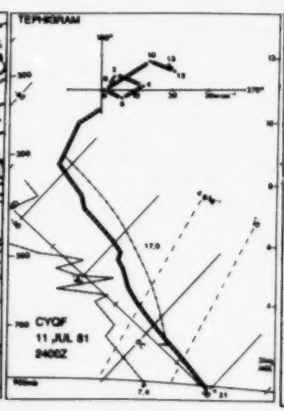
Flights	5
Hours	11.0
Top Flares	
Base Flares	8
Acetone Gen.	Imp. Gal.

DATE

July 9, 1981

Isolated weak rainshowers early afternoon throughout the northwest quadrant tops approximately 20K. Later in day and early evening, weak rainshowers Water Valley, Caroline, Gull Lake and north of Rimbey. Maximum tops 25K Water Valley area. Late evening activity Sundre area tops 24K.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	11
Pea	20
Grape	8
Walnut	
Golfball	
>Golfball	
Unknown	1

Median Hail Time 14:45

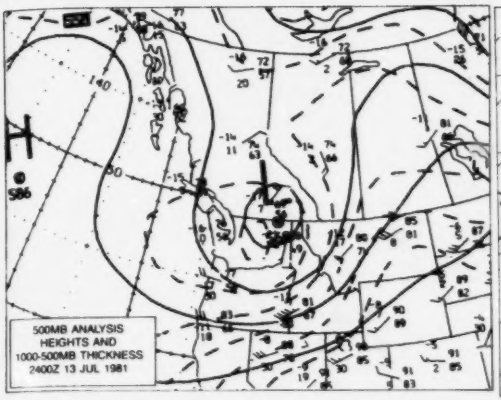
CLOUD SEEDING SUMMARY

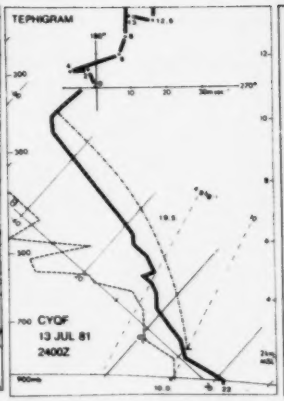
Flights	11
Hours	15.7
Top Flares	511
Base Flares	10
Acetone Gen.	5.9 Imp. Gal.

DATE

July 11, 1981

Weak line of cells developed west of Caroline northeast to Pigeon Lake early afternoon, tops to 30K. Line moved southeast passing through Caroline, Rocky Mountain House, Alder Flats, Rimbey and Pigeon Lake. By 1600, line began to weaken and by 1700 only weak rainshowers west of Innisfail and Rocky Mountain House northeast to Rimbey.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	3
Pea	22
Grape	7
Walnut	
Golfball	
>Golfball	
Unknown	1

Median Hail Time 13:30

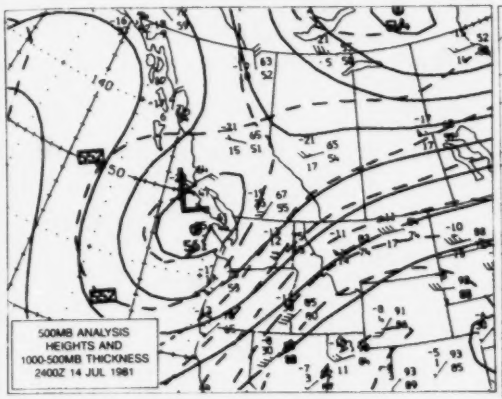
CLOUD SEEDING SUMMARY

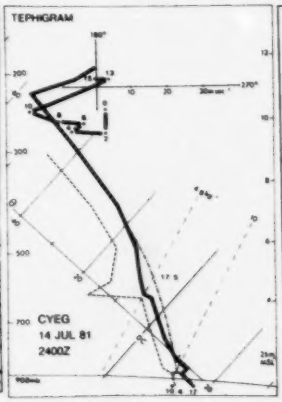
Flights	11
Hours	24.5
Top Flares	330
Base Flares	52
Acetone Gen.	3.9 Imp. Gal.

DATE

July 13, 1981

Early morning activity from previous day west of Innisfail and in the Buffalo Lake area. Throughout the afternoon, widespread storm activity, mostly weak, but some moderate intensity storms Rocky Mountain House area, tops 32K, Gull Lake to Buffalo Lake, tops 25K. After 1900, storm activity confined to mountains 70-80 miles west of Penhold.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	22
Pea	39
Grape	11
Walnut	4
Golfball	2
>Golfball	
Unknown	9

Median Hail Time 05:00

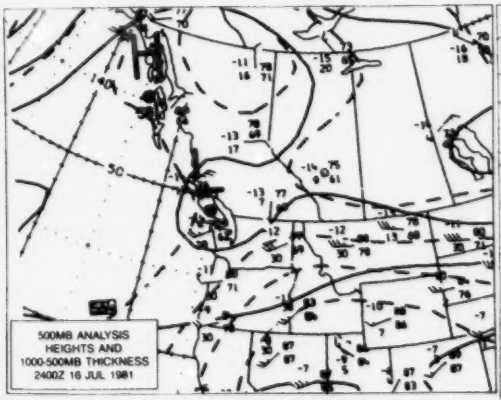
CLOUD SEEDING SUMMARY

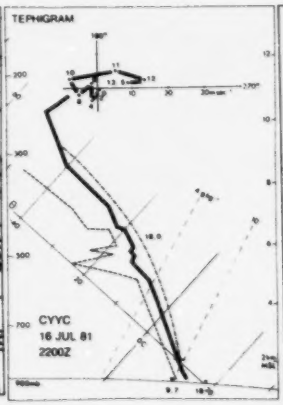
Flights	1
Hours	1.3
Top Flares	
Base Flares	
Acetone Gen.	Imp. Gal.

DATE

July 14, 1981

Widespread moderate to heavy rainshowers throughout the project area, condition persisted overnight. Hail reports are from overnight storms (early morning 14 July).





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	1
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 16:25

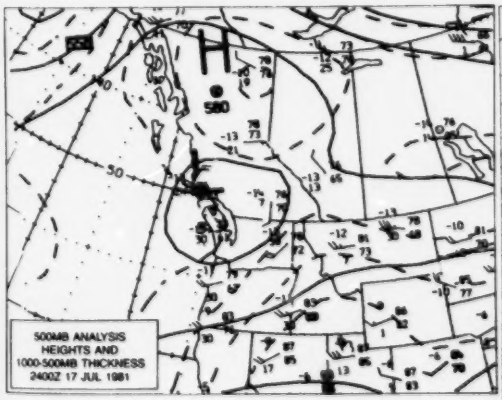
CLOUD SEEDING SUMMARY

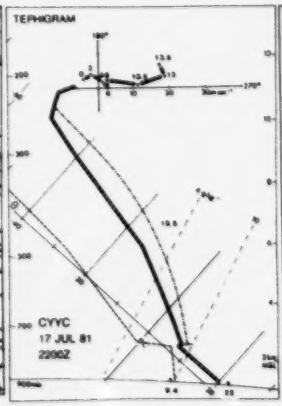
Flights	5
Hours	12.9
Top Flares	
Base Flares	42
Acetone Gen.	2.6 Imp. Gal.

DATE

July 16, 1981

Numerous small storms, western half of area.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time

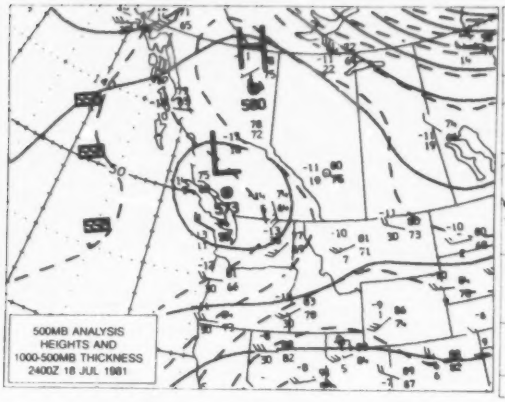
CLOUD SEEDING SUMMARY

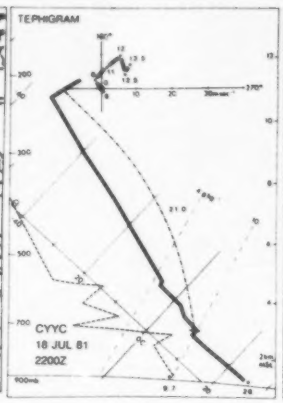
Flights	4
Hours	12.7
Top Flares	25
Base Flares	
Acetone Gen.	Imp. Gal.

DATE

July 17, 1981

Storms in foothills west of Cremona during afternoon - little motion.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	1
Pea	2
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 16:00

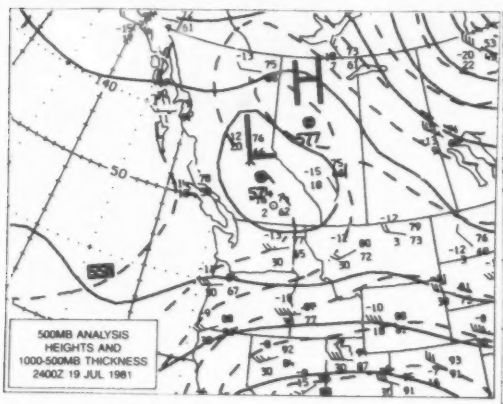
CLOUD SEEDING SUMMARY

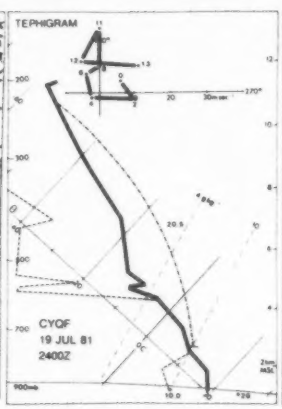
Flights	6
Hours	10.5
Top Flares	10
Base Flares	8
Acetone Gen.	1.1 Imp. Gal.

DATE

July 18, 1981

Storms along foothills only during afternoon with tops to 34K.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	18
Pea	31
Grape	60
Walnut	17
Golfball	3
>Golfball	
Unknown	2

Median Hail Time 17:00

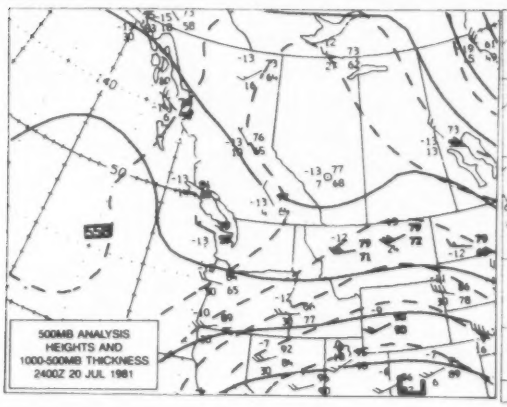
CLOUD SEEDING SUMMARY

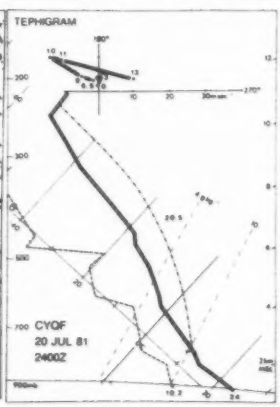
Flights	10
Hours	25.2
Top Flares	607
Base Flares	79
Acetone Gen.	9.81 Imp. Gal.

DATE

July 19, 1981

Development along foothills early afternoon extended from Cochrane to north Crimson Lake by 15:00. Moved slowly Northeast to highway 21 by evening widely scattered pea to grape hail north Rocky to Gilby, pea to walnut hail northwest Cochrane to Airdrie, Acme, Three Hills, Rumsey and east Morrin with golfball hail at Airdrie and east of Trochu.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	17
Pea	52
Grape	44
Walnut	4
Golfball	
>Golfball	
Unknown	1

Median Hail Time 17:30

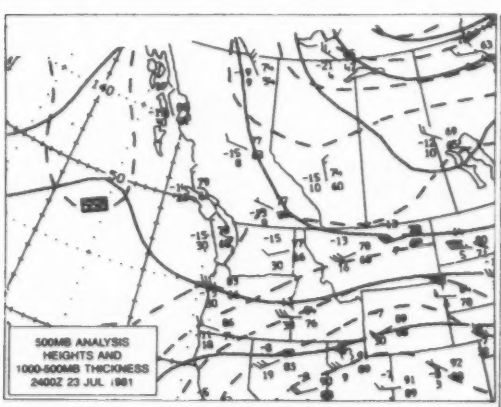
CLOUD SEEDING SUMMARY

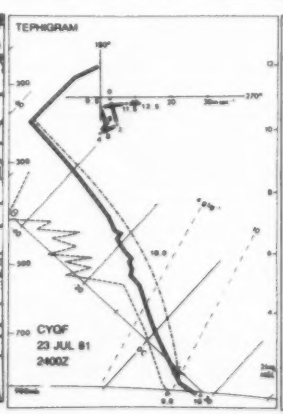
Flights	9
Hours	26.8
Top Flares	888
Base Flares	65
Acetone Gen.	2.6 Imp. Gal.

DATE

July 20, 1981

Widely scattered storms developed early afternoon Camrose, Rimbey, Cochrane and along foothills with tops to 44K. foothills activity spread to Sundre to Sylvan Lake late afternoon. Evening storms Three Hills, Big Valley, Elnora, Gull and Pigeon Lakes. Pea to grape hail south Canmore, north Gadsby, Byemoor, Munsen, Delburne, Blackfalds, east Sundre, Leedale, Pigeon Lake.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	3
Pea	4
Grape	1
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 17:00

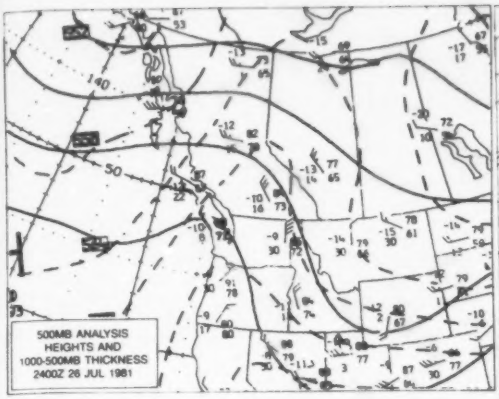
CLOUD SEEDING SUMMARY

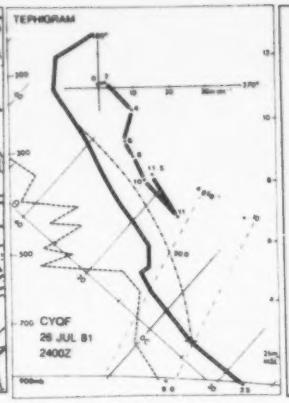
Flights	6
Hours	12.6
Top Flares	
Base Flares	7
Acetone Gen.	11.1 Imp. Gal.

DATE

July 23, 1981

Cloud with rainshowers throughout the area, some briefly to 50 - 55 dBZ.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time: _____

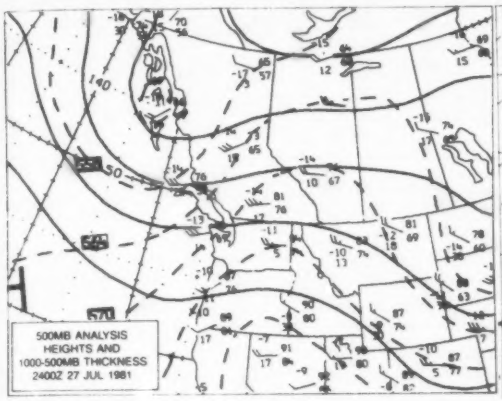
CLOUD SEEDING SUMMARY

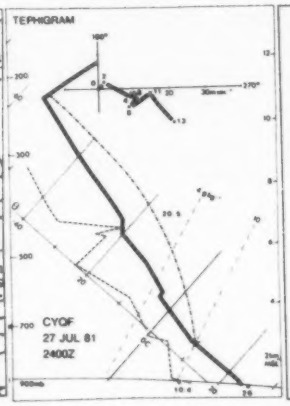
Flights	3
Hours	5.3
Top Flares	40
Base Flares	
Acetone Gen.	_____ Imp. Gal.

DATE

July 26, 1981

Isolated TCU, occasional rainshowers. Tops approximately 20K during afternoon.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	8
Pea	47
Grape	15
Walnut	
Golfball	
>Golfball	
Unknown	2

Median Hail Time: 21:30

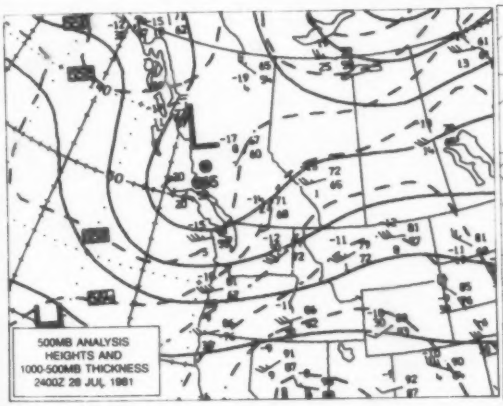
CLOUD SEEDING SUMMARY

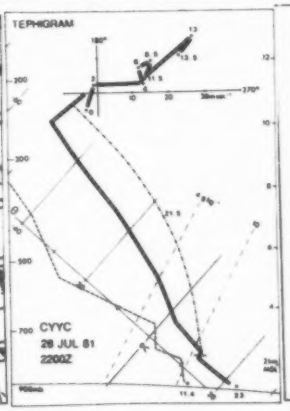
Flights	10
Hours	22.5
Top Flares	631
Base Flares	56
Acetone Gen.	_____ Imp. Gal.

DATE

July 27, 1981

Widely scattered cells during the afternoon with some pea hail Sundre area. A long North - South line moved eastward across the project area during late evening with tops to 40K and two cells with approximately 55 dBZ.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	13
Pea	25
Grape	28
Walnut	32
Golfball	21
>Golfball	5
Unknown	

Median Hail Time: 16:45

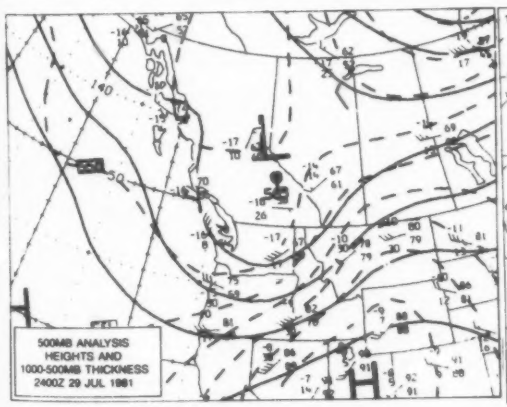
CLOUD SEEDING SUMMARY

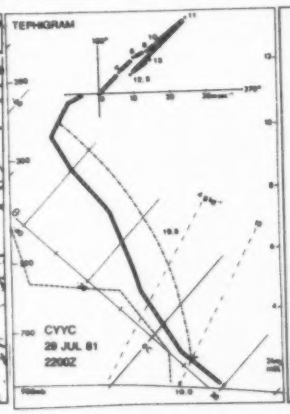
Flights	8
Hours	21.3
Top Flares	557
Base Flares	36
Acetone Gen.	5.9 Imp. Gal.

DATE

July 28, 1981

Severe storms along foothills during the afternoon, tops 35 - 40K. Three more cells moved east: Rocky Mountain House to Red Deer, Caroline to Olds and Cochrane to Calgary to Rockyford to Strathmore area during evening. Golfball hail in Calgary. Weak line of activity (tops 25K) moved across the project area late evening.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	26
Pea	44
Grape	18
Walnut	3
Golfball	1
>Golfball	
[illegible]	1

Median Hail Time: 17:45

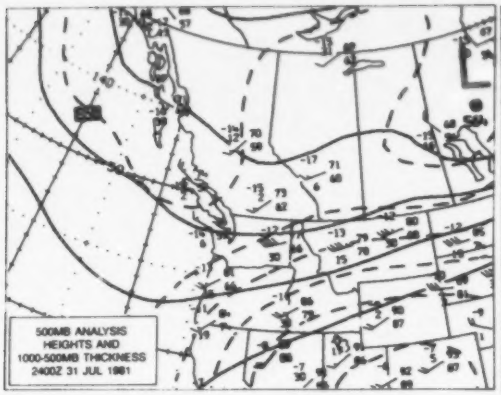
CLOUD SEEDING SUMMARY

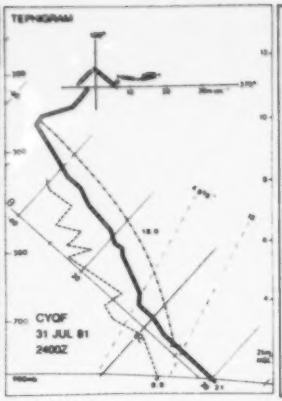
Flights	9
Hours	15.4
Top Flares	268
Base Flares	3
Acetone Gen.	2.0 Imp. Gal.

DATE

July 29, 1981

Weak rainshowers early afternoon throughout the northern project area and southeast of Sundre, tops 20 - 24K. Later in afternoon, activity began to pick up in the Sundre and Rocky Mountain House areas with tops to 33K and 51 - 53 dBZ. Storms tracked generally eastward with major activity Cremona north to Eckville. Storms dissipated just east of Highway #2 early evening. Other storm areas early evening: Big Valley, north of Drumheller and over Calgary.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	3
Pea	8
Grape	5
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 19:12

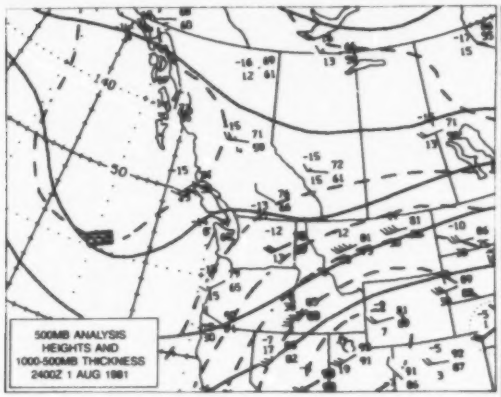
CLOUD SEEDING SUMMARY

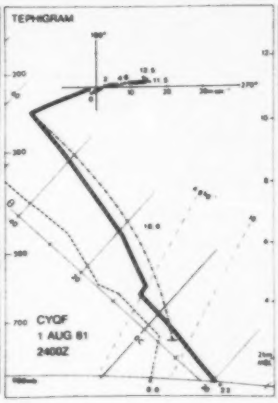
Flights	9
Hours	19.3
Top Flares	38
Base Flares	36
Acetone Gen.	6.7 Imp. Gal.

DATE

July 31, 1981

Storm cells began forming along foothills early afternoon, moved slowly eastward. Main cells: Rocky Mountain House, Caroline, Sundre to Cremona, tops 23 - 27K. By mid afternoon, only an area from Didsbury to Olds remained active, tops 29K. Early evening, new development Rimbey to Caroline and later north to Pigeon Lake. Also small cell Acme area. By 2100, only weak cells north of Red Deer.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	3
Pea	9
Grape	3
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 17:00

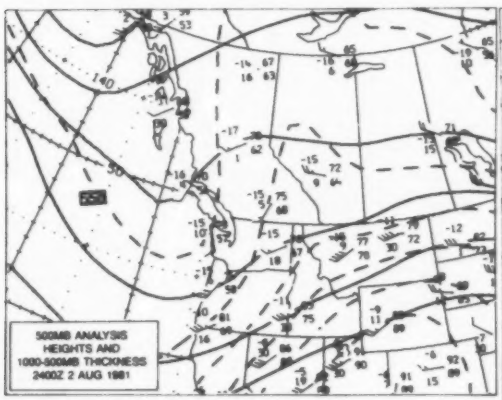
CLOUD SEEDING SUMMARY

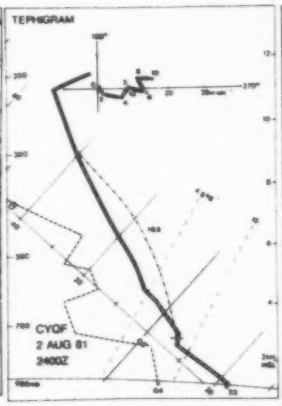
Flights	6
Hours	18.6
Top Flares	109
Base Flares	17
Acetone Gen.	11.0 Imp. Gal.

DATE

August 1, 1981

Weak storms early afternoon Water Valley, north of Crimson Lake, Leedale and Panoka, tops 22 - 25K. By mid afternoon, numerous areas of weak activity: Rocky Mountain House, Rimbey, Panoka, Delburne, east of Rumsey, Sundre and Cremona; maximum tops 29K Alder Flats area. Storms tracked slowly eastward and would build and die rapidly in those areas all day. By early evening, a major storm started in the Rocky Mountain House area and tracked eastward to Red Deer, tops 37K, 54 dBZ.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	9
Pea	5
Grape	6
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 21:30

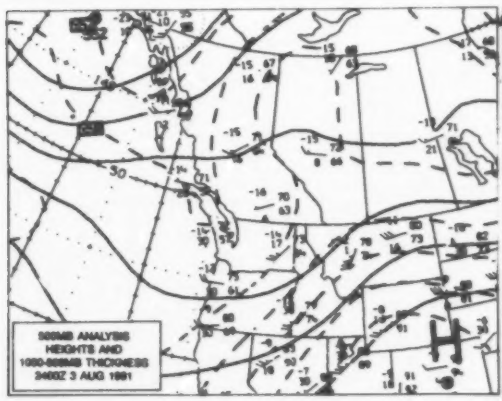
CLOUD SEEDING SUMMARY

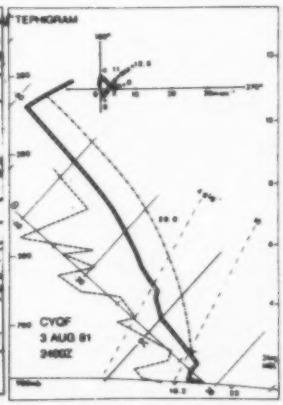
Flights	4
Hours	12.8
Top Flares	191
Base Flares	28
Acetone Gen.	4.0 Imp. Gal.

DATE

August 2, 1981

Storm activity began early afternoon Pigeon Lake and extreme east project area, tops 30K east. Later, activity formed foothills southwest of Sundre and tracked slowly eastward, tops 35K, however, storms died leaving foothills. About 2200 activity began to pick up 80 miles northwest of Penhold and eventually formed a line that tracked across the north project area. Storms persisted past midnight.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	11
Pea	25
Grape	22
Walnut	
Golfball	
>Golfball	
Unknown	1

Median Hail Time 17:22

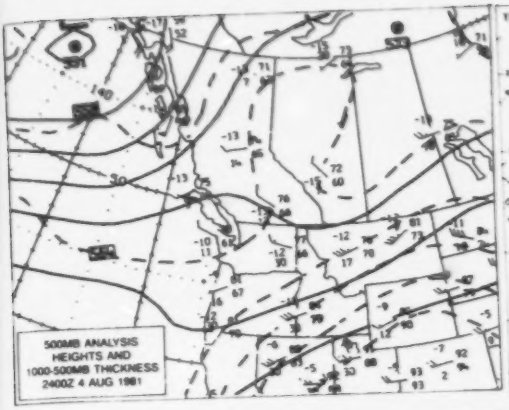
CLOUD SEEDING SUMMARY

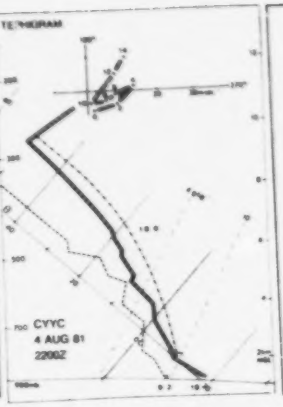
Flights	6
Hours	16.9
Top Flares	48
Base Flares	27
Acetone Gen.	14.7 Imp. Gal.

DATE

August 3, 1981

Storm activity began along foothills southwest early afternoon and moved slowly eastward, tops 38K, some cells to 58 dBZ. However, storms dissipated east of Sundre. Throughout much of the day, cells continued to develop in a north - south line from Cochrane to Caroline. Early evening activity Lacombe Acme and Big Valley.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	9
Pea	29
Grape	6
Walnut	1
Golfball	
>Golfball	
Unknown	

Median Hail Time 15:30

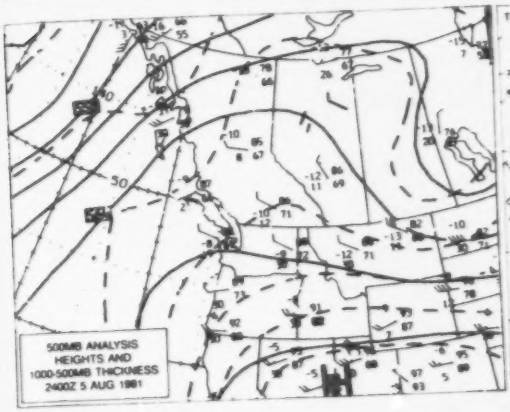
CLOUD SEEDING SUMMARY

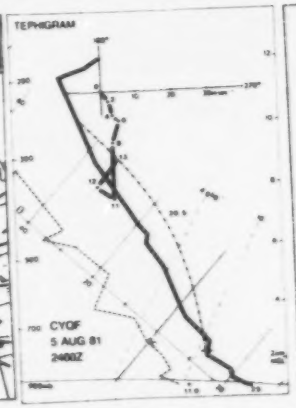
Flights	5
Hours	24.7
Top Flares	31
Base Flares	48
Acetone Gen.	4.3 Imp. Gal.

DATE

August 4, 1981

Activity began mid afternoon Carstairs, Rimbey and extreme east project area. Maximum tops 32K storms tracked eastward. Other areas of activity: west of Three Hills, Byemoor, Balburne, north of Stettler, east and south of Camrose late afternoon and early evening.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time

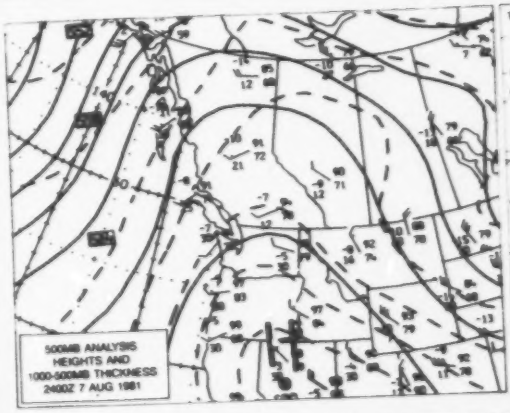
CLOUD SEEDING SUMMARY

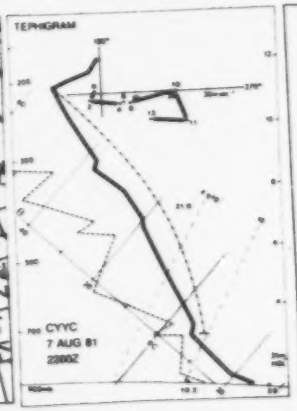
Flights	6
Hours	6.4
Top Flares	253
Base Flares	
Acetone Gen.	Imp. Gal.

DATE

August 5, 1981

Small but intense cell north of Gull Lake mid afternoon also numerous cells along foothills southwest of Sundre. Storms died leaving foothills.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	2
Pea	3
Grape	1
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 15:52

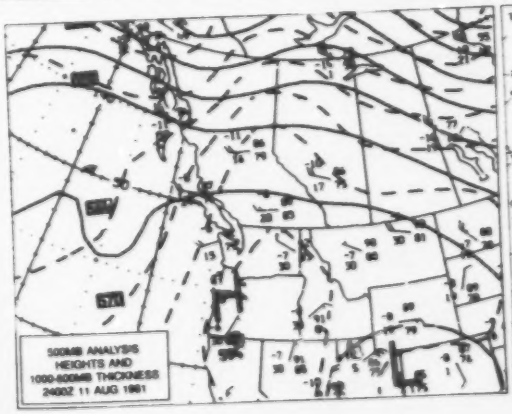
CLOUD SEEDING SUMMARY

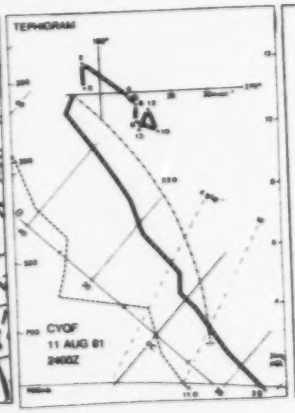
Flights	1
Hours	3.2
Top Flares	
Base Flares	2
Acetone Gen.	Imp. Gal.

DATE

August 7, 1981

Storm activity along the mountains extreme west and southwest project area afternoon to evening, tops to 38K and 59 dBZ. Tracked south - southeast. Other area of weaker activity late afternoon south of Cremona, tops 25K.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time

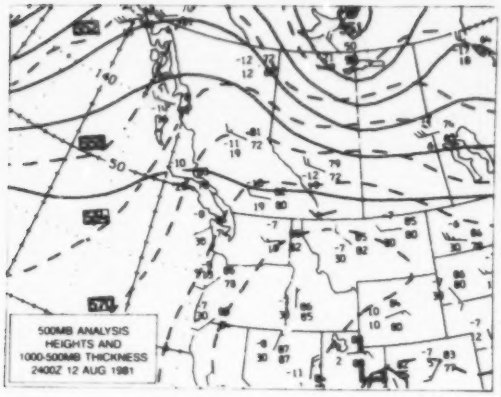
CLOUD SEEDING SUMMARY

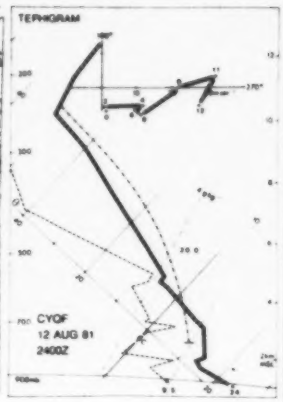
Flights	5
Hours	5.3
Top Flares	
Base Flares	16
Acetone Gen.	Imp. Gal.

DATE

August 11, 1981

A single cell to 33K, 80 miles west of Penhold mid afternoon, tracked slowly south and never did pose a threat to the project area. Another smaller cell developed southeast of Carseland but died leaving the foothills.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	3
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 21:30

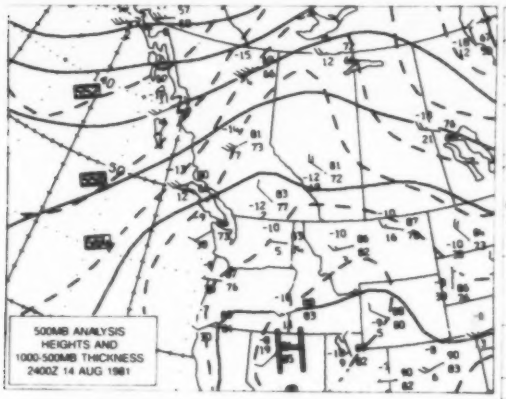
CLOUD SEEDING SUMMARY

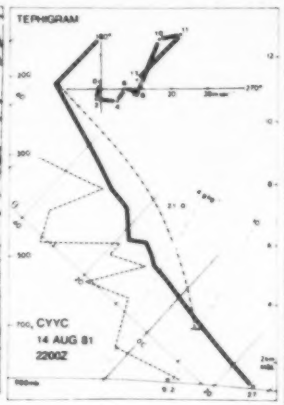
Flights	5
Hours	7.5
Top Flares	
Base Flares	11
Acetone Gen.	Imp. Gal.

DATE

August 12, 1981

A fast moving cold front passed through the project during the early part of the day, setting off isolated thundershowers. Skys cleared rapidly in afternoon except for some large cells over the mountains 80 miles west and southwest of Penhold which remained outside the project area as they tracked south - southeast. Overnight activity north project area.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	2
Pea	8
Grape	5
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 05:00

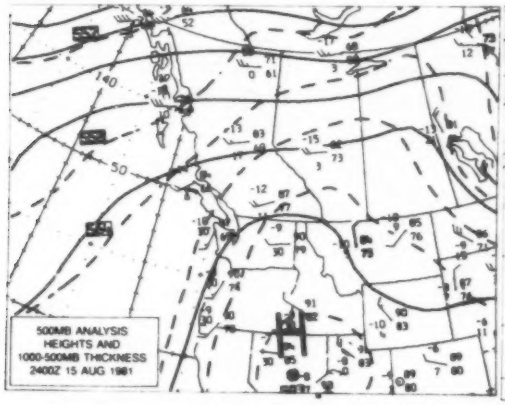
CLOUD SEEDING SUMMARY

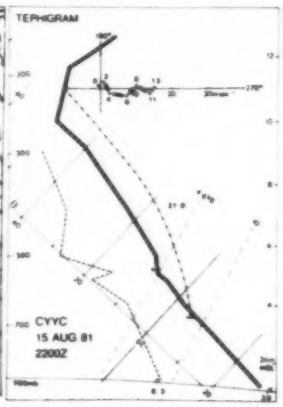
Flights	5
Hours	11.2
Top Flares	142
Base Flares	19
Acetone Gen.	Imp. Gal.

DATE

August 14, 1981

Storms over mountains 80 - 90 miles southwest late afternoon. Also some late evening activity northwest Red Deer, and 60 - 80 miles northeast of Red Deer.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	4
Pea	15
Grape	20
Walnut	6
Golfball	1
>Golfball	
Unknown	1

Median Hail Time 16:30

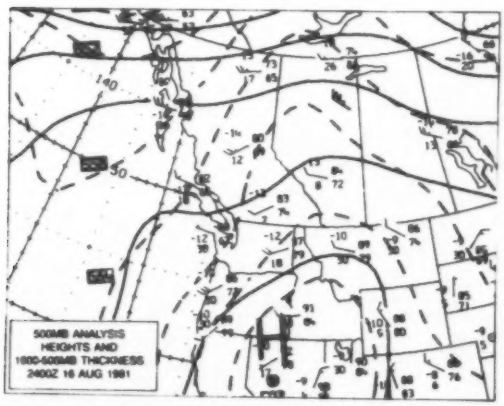
CLOUD SEEDING SUMMARY

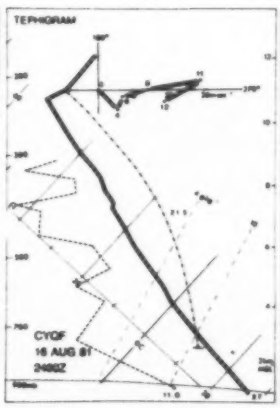
Flights	5
Hours	14.3
Top Flares	106
Base Flares	22
Acetone Gen.	6.0 Imp. Gal.

DATE

August 15, 1981

Storms formed over mountains west and northwest quadrants early afternoon. Major storm formed Ram River area and tracked southeast through Calgary early evening, tops 42K.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	
Pea	2
Grape	3
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 16:30

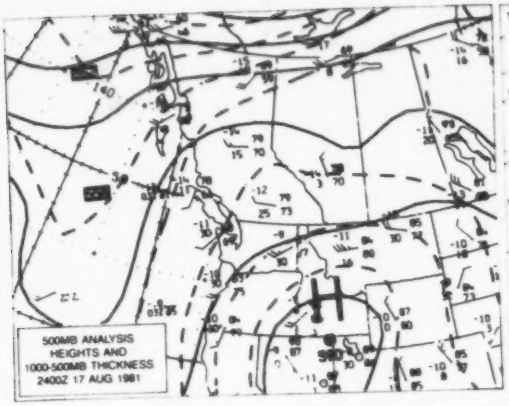
CLOUD SEEDING SUMMARY

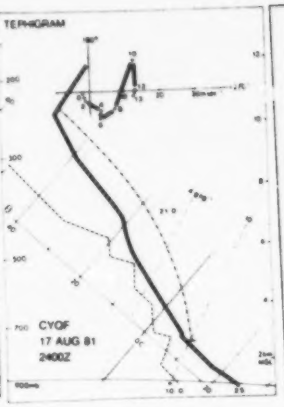
Flights	7
Hours	10.6
Top Flares	31
Base Flares	3
Acetone Gen.	Imp. Gal.

DATE

August 16, 1981

Several weak storms over the mountains from west of Rocky Mountain House southward. One moderately intense storm west of Cremona moved eastward. Late evening storm Calgary area.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	9
Pea	17
Grape	23
Walnut	2
Golfball	
>Golfball	
Unknown	

Median Hail Time 16 30

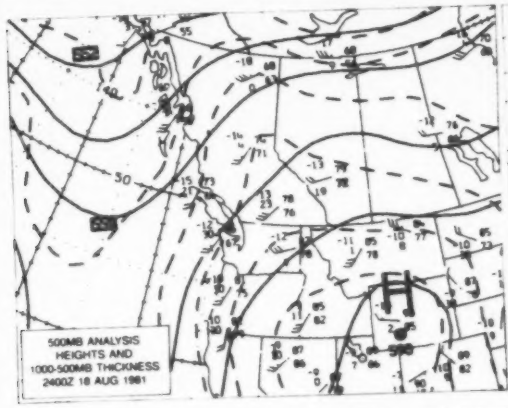
CLOUD SEEDING SUMMARY

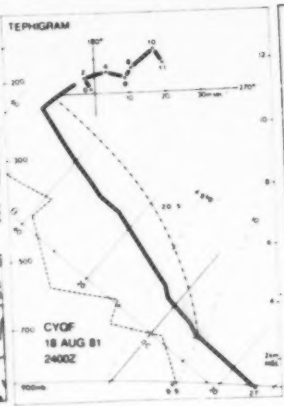
Flights	13
Hours	22.3
Top Flares	164
Base Flares	44
Acetone Gen	4.0 Imp. Gal

DATE

August 17, 1981

Storms started early afternoon 60 - 70 miles southeast of Penhold. Storms tracked southeast over Cochrane, Airdrie and Calgary, then northward to Acme. Eventually a north - south line formed from Irricana to Trochu late in afternoon, tops to 40K and 61 dBZ. Also at this time a cell formed over Rumsey and tracked southeast eventually forming a east - west line from Three Hills to Delia. Whole system dissipated about 2000 in Drumheller area.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	2
Pea	5
Grape	1
Walnut	1
Golfball	
>Golfball	
Unknown	

Median Hail Time 19 53

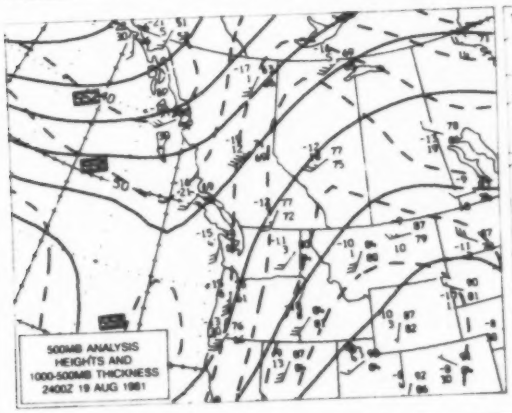
CLOUD SEEDING SUMMARY

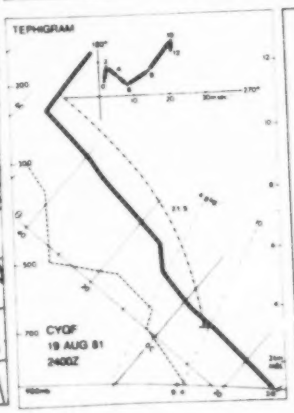
Flights	5
Hours	14.8
Top Flares	88
Base Flares	22
Acetone Gen	Imp. Gal.

DATE

August 18, 1981

A late afternoon storm developed 80 miles west of Penhold and tracked eastward dissipating in the Caroline area about 2000. Tops 41K, 58 dBZ. Another single storm developed about 1900, 15 northwest of Forestburg, tracked northeast leaving the project area south of Bayland about 2100.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	2
Pea	2
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	

Median Hail Time 16 00

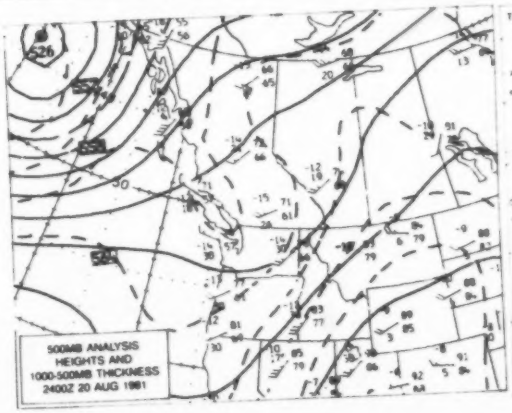
CLOUD SEEDING SUMMARY

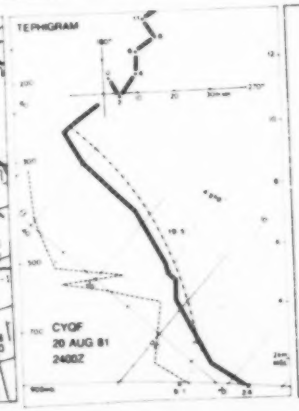
Flights	6
Hours	12.5
Top Flares	161
Base Flares	
Acetone Gen	2.6 Imp. Gal.

DATE

August 19, 1981

Mid afternoon activity Rocky Mountain House area with a line of storms forming north of Alder Flats. Storms were short lived, dissipating in the Leedale/Echville areas about 1700. Storms tracked northeast, maximum tops 35K.





HAIL DATA SUMMARY

HAIL REPORTS

Size	
Shot	1
Pea	3
Grape	
Walnut	
Golfball	
>Golfball	
Unknown	2

Median Hail Time 21 25

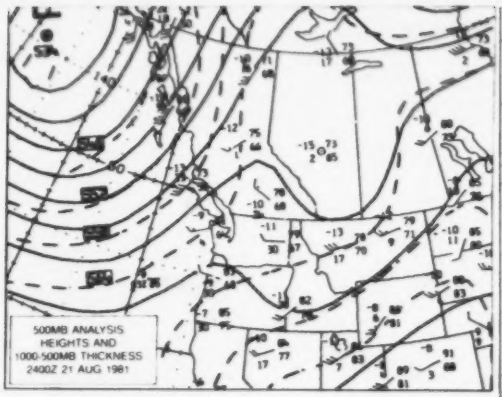
CLOUD SEEDING SUMMARY

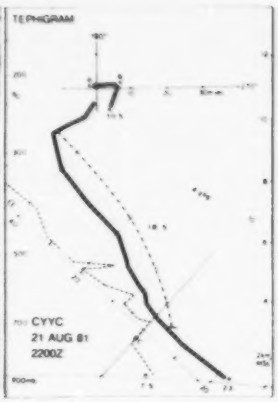
Flights	9
Hours	13.2
Top Flares	78
Base Flares	17
Acetone Gen	7.0 Imp. Gal.

DATE

August 20, 1981

Early evening activity Crimson Lake and 20 northwest of Limestone Mountain. Storms dissipated leaving the foothills. After 2000, a line of storms developed from Caroline to Sundre, tops 32K, 52 dBZ. Line tracked east - northeast dissipation east of Red Deer after midnight. Other storms Water Valley and Cochrane late evening.





HAIL DATA SUMMARY

HAIL REPORTS

[illegible]	5
[illegible]	19
[illegible]	5
[illegible]	
[illegible]	
[illegible]	
[illegible]	

Median Hail Time 16:30

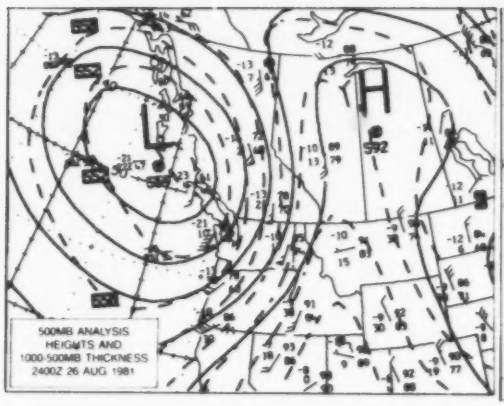
HAIL SEEDING SUMMARY

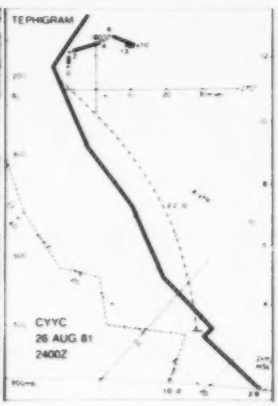
[illegible]	44
[illegible]	28.8
[illegible]	56.7
[illegible]	58
[illegible]	13.7 thsd. Gals.

DATE

August 21, 1981

Storm activity began early afternoon southwest of Cremona, Caroline to Rocky Mountain House, west to Bentley, Sylvan Lake and Pine Lake. Small isolated storms continued to build and dissipate rapidly in numerous locations throughout the project area. Most active areas: Water Valley to Carstairs, east of Red Deer, Delburne/ Big Valley to Rumsey, Acme and south of Sundre. Maximum tops 38K.





HAIL DATA SUMMARY

HAIL REPORTS

[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	
[illegible]	

Median Hail Time not applicable

HAIL SEEDING SUMMARY

[illegible]	3
[illegible]	6
[illegible]	
[illegible]	
[illegible]	thsd. Gals.

DATE

August 26, 1981

Storm activity along mountains extreme southwest project area. No threat to operations area.

APPENDIX 7

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POOR

QUALITY

ORIGINAL